THE HAWAIIAN PLANTERS' MONTHLY

PUBLISHED FOR THE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

Vol. XXIII.] HONOLULU, JANUARY 15, 1904. [No. 1

HAWAIIAN FORESTER AND AGRICULTURIST.

Beginning with this issue, the "Hawaiian Planters' Monthly" will include within its covers the "Hawaiian Forester and Agriculturist," a monthly magazine of Forestry, Entomology and Agriculture, edited under the direction of the Board of Commissioners of Agriculture and Forestry.

The Board of Commissioners of Agriculture and Forestry desired to have a publication which would be devoted entirely to the agricultural industries of the country other than sugar cane, and containing matters of interest in reference to Forestry, Entomology and Agriculture, and the Planters' Asoociation have agreed to allow a certain portion of this publication to be taken over by the Commissioners for the purpose of their journal.

The "Hawaiian Forester and Agriculturist" is issued and edited entirely by the Board of Commissioners. It will, as we know, be a live journal, and with the assistance of the Federal and Territorial agricultural specialists, should contain a great deal of interesting matter. Being edited under the direction of the Commissioners, it will, of course, be an official publication of that body, and will keep us all informed of what is being done by that body.

The Hawaiian Sugar Planters' Association is in sympathy with, and is disposed to lend its aid and assistance to, the government and to the Commissioners of Agriculture and Forestry in agricultural and forestry matters. Were it not for the assistance given by the Planters' Association and its members, it would be not only impracticable, but impossible, to carry out the plans of the government in the lines of forest preservation and development. A great many of the volunteer foresters appointed by the government are sugar plantation men and managers, and their hearty co-operation is essential to the successful carrying out of the government's plans.

Subscribers for the "Planters' Monthly" will receive the "Hawaiian Forester and Agriculturist" without additional charge. All communications to the "Hawaiian Planters' Monthly" should be addressed to the editor as usual, and communications to the "Forester and Agriculturist" should be addressed to W. M. Giffard.

NOTES.

We are publishing this month the remainder of Miss Coman's paper on labor in Hawaii. This should have been published in the December number, but was crowded out by the reports presented at the annual meeting of the Association.

We also publish the paper of Mr. William Stodart on machinery presented at the annual meeting of the Planters' Association. There are a number of cuts or diagrams referred to in this article, but, as they are principally blue prints and in color, it would be a matter of considerable time and delay to have them redrawn and put in such form as to enable the publisher to incorporate them in the article; we have therefore omitted the cuts in order to publish the report in this number.

The list of committees appointed by the president of the Association appears in this number. This year it is desired that the committees have their reports in course of preparation through the year, and that a complete report of each committee be in the hands of the Secretary of the Association at least one month before the annual meeting, which will occur probably in November. This is a matter of importance and if carried out will assist materially in intelligent discussion of such reports.

STANDING COMMITTEES HAWAIIAN SUGAR PLANTERS' ASSOCIATION FOR THE YEAR ENDING NOVEMBER 30, 1904.

1. LABOR:—E. F. Bishop, Chairman; P. McLane, F. B. McStocker, H. A. Baldwin, H. H Renton.
2. CULTIVATION:—Andrew Adams, Chairman; B. D. Baldwin, John Hind, E. Madden, John A. Scott, C. B. Wells.
3. FERTILIZATION:—C. F. Eckart, Chairman; D. Forbes, Geo. Ross, Wm. Stodart, Geo. Gibb, Aug. Ahrens.
4. IRRIGATION:—W. W. Goodale, Chairman; L. Barkhausen, John Sherman, F. Weber, F. Meyer.
5. HANDLING AND TRANSPORTATION OF CANE:—Geo. F. Renton, Chairman; C. C. Kennedy, John M. Horner, Geo. Chalmers, H. P. Faye, D. C. Lindsay.
6. MANUFACTURE:—J. N. S. Williams, Chairman; T. C. Davies, G. H. Fairchild, J. T. Moir, Aug. Ahrens, S. K. Gjerdrum.

7. MACHINERY:—C. Hedeman, Chairman; Aug. Ahrens, T. C. Davies, James Scott, Wm. Stodart, John Hind, C. C. Kennedy.

8. UTILIZATION OF BY-PRODUCTS:—G. H. Fairchild, Chairman; James Gibb, W. G. Walker, Andrew Adams, H. Deacon, J. N. S. Williams, T. C. Davies.

9. DISEASES OF CANE:—R. C. L. Perkins, Chairman; C. F. Eckart, G. H. Fairchild, Aug. Ahrens, James Gibb, H. A. Baldwin, D. Forbes.

10. FORESTRY:—L. A. Thurston, Chairman; Walter Dillingham, H. A. Baldwin, E. E. Olding, D. Forbes, Geo. Ross, J M. Lydgate.

11. EXPERIMENT STATION:—W. M. Giffard, Chairman; Geo. Robertson, Andrew Adams, H. A. Isenberg, J. M. Dowsett, E. E. Paxton, G. M. Rolph

12. LABOR SAVING DEVICES:—J. A Low, Chairman; F. Meyer, J. N. S. Williams, F. B. McStocker, A. Lidgate, T. S. Kay, E. K. Bull.

REPORT ON MACHINERY.

BY WM. STODART.

To the President and Members of the Hawaiian Sugar Planters' Association:—

Gentlemen:—I herewith present to you the following report on machinery:

In the reports on machinery for 1901 and 1902, you have had a full detailed description of all the machinery installed in the new modern sugar factories erected on these islands during the past few years.

There has been little said, however, about the cost of manufacture per ton and the total losses in these modern houses, and it seems to me it would be wise for us to compare the efficiency and cost of the work of these new factories in detail (conditions considered) with a view to determine, if possible, the best machinery to install in future mills, and the actual saving which has been accomplished in manufacture during the past few years with our modern machinery.

I am of the opinion that we would all be benefited more or less if the results of milling in our factories from year to year could be tabulated in some form or other and presented at the annual meetings of the Hawaiian Sugar Planters. Special care should be taken, however, by every one interested to report the cost of all operations and supplies correctly, so that the figures will be of recognized value. In order that these statistics should be uniform and continuous, it might be well for the Secretary of your Association to secure and present this information at your annual meetings.

To those who are contemplating the erection of new factories this table should be of value (existing conditions on each plantation considered), setting forth, as it does, the total cost of manufacture in detail, including 6 per cent. interest on the mill investment.

The first cost of machinery, with the necessary buildings, has a direct bearing on the cost of manufacture. It would be wise, therefore, for us to consider if it is at all possible to reduce the first cost of these modern plants without reducing their efficiency in any way. The machinery for a modern sugar factory should be, of course, plain, strong and substantial, of good design, compactly and conveniently arranged, and the very best obtainable, as well as being fitted with all the latest improved labor-saving devices.

In my opinion, little can be saved on machinery for future installations if we are to maintain and improve the efficiency of our factories to the highest possible standard. The buildings should also be substantial, and as plain as it is possible to make them, without any expensive ornamentations, which, needless, to say, are quite useless and unnecessary.

The general practice of placing the crystallizers between the vacuum pans and the mixers to allow the massecuite to flow by gravity from one receptacle to the other, is no doubt an ideal arrangement, but, in my opinion, a very expensive one, necessitating, as it does, a very high structure, expensive foundations and heavy "I" beam supports. I estimate that a saving of from 30 to 50 per cent. can be effected on the first cost of buildings for factories designed to turn out from 100 to 150 tons of raw sugar per day, without lessening the durability or efficiency in any way, by avoiding all kinds of useless ornamentations and by placing and arranging the crystallizers on the ground floor of the factory, using compressed air to force the massecuite after treatment in the crystallizers to the mixers above. This system was in operation for handling No. 3 massecuite at the McBryde Sugar Co.'s mill during the manufacture of the whole of the 1903 crop. It was found to be easily operated, efficient and otherwise satisfactory.

UNLOADING CANE AT THE CARRIER WITH THE MALLON & BODLEY MACHINE AT THE McBRYDE SUGAR CO.'S FACTORY.

This machine was installed in January of this year, and was in operation for six months during the milling of the crop with the following results:

The actual cost of handling the cane by this method ,including cost of mules at 40 cents per day each, weighing, and all operations necessary from and to the storage tracks for loaded and empty cars, was 2.69c. per ton of cane, as against 4.11c. for the previous crop by ordinary hand labor, or a saving of 35 per cent. over the old method. The average amount of cane handled per 24 hours was 735 1-2 tons, which is considerably less than its actual capacity, so that a further reduction in the cost per ton may be expected if the machine is run up to its full capacity.

Mr. J. N. S. Williams gives the cost of handling cane at the Puunene Mill with the Gregg machines, under practically the same conditions as above, at 2 1-2c per ton. This would seem that the one machine has very little advantage over the other, and it may be taken for granted that they can both be operated under similar conditions with about the same degree of economy.

WATER DRIVEN CENTRIFUGALS.

I am indebted to Mr. George W. Connon, chief engineer of the factory, for the following description, with drawings, showing the original as well as the new plan of piping installed at the McBryde Sugar Company's mill at the commencement of last crop:

"In nearly all sugar factories in these islands, where water-driven centrifugals have been installed, they have not, without some changes, worked satisfactorily. This was owing to the centrifugal taking too long to come up to full speed, and when at full speed being too slow to dry a charge quickly. This has not been due to any inherent defect in the method of driving, but either to poorly-designed piping (causing excessive friction), or to inadequate pump power, giving too slow a pressure in the pipe line. The first season's work (1902), with the water-driven centrifugals at this factory, was very unsatisfactory. The daily output of sugar was then 60 tons, and it required 16-40 inch centrifugals to dry this amount, owing to the fact of their running so slowly. Before commencing this year's crop, the arrangement of the piping was changed, and this change made a very great improvement in their work.

Our centrifugal plant consists of 16-40 inch and 2-30 inch machines, divided into two batteries. One battery for first sugars, made up of 8-40 inch and 2-30 inch centrifugals; the other battery of 8-40 inch centrifugals is used for drying the low-grade sugars. Each set is independent of the other, each having its own pump. Three direct-acting pumps are used—two are 20x10x10, and one is 16x10x12. The 30-inch centrifugals have a single nozzle, and the 40-inch have double nozzels, attached to a single branch on the pressure main.

The original arrangement of the piping is shown in Fig. 1. The battery of centrifugals for first sugars is driven by one of the 20x10x10 pumps and the 16x10x12; the other 20x10x10 pump serves the centrifugals for low grade sugars. With this arrangement, and the pumps running at a piston speed of about 100 feet per minute, a pressure of not more than 120 pounds per square inch could be maintained in the pressure main. The 16x10x12 pump having a steam cylinder of a much smaller area than the other pump, would stop when the steam pressure went below 70 pounds per square inch, putting all the work on the other pump. The pumps gave a good deal of trouble by the valves breaking and pounding badly.

Figure 2 shows our present arrangement of piping. In making this change the pumps were not moved. It was made with the idea of discarding the three pumps at some future time, replacing them with one pump, and putting it in the position shown in Fig. 3. This will make a much simpler and better arrangement of the piping. The two 20x10x10 pumps are connected to the battery of centrifugals for first sugars, and the 16x10x12 serves the second sugar centrifugals. This pump had to be connected independently of the other two, so that in the event of a fall in steam pressure it would continue to work.

The piping is laid out in what is known as the circular feed; the main pressure pipe above the centrifugals is continued back to the delivery pipe of the pump, thus making a complete circuit. This reduces friction and prevents shocks in the pipe line. All elbows and bends are made with large radii. The piping of the two batteries is connected and valves introduced, so that, in the event of a breakdown of any one of the pumps, these valves could be opened and thus prevent the shutting down of any set of centrifugals while the pump was being repaired. A large air chamber, with a capacity of 56 cubic feet, was added to prevent any fluctuation of pressure due to the starting and stopping of several centrifugals at one time. This air chamber was made from a piece of 24-inch pipe. The reason for bringing the air chamber out to the position shown in the drawing was to clear the vacuum pan floor, and it is also better situated for the future location of the pump.

After this change we found no difficulty in keeping up a pressure of 200 pounds per square inch in our first sugar centrifugals, and 160 pounds in our centrifugals for second sugars, with the pumps running at a piston speed of 50 feet per minute. With these pressures our centrifugals work quite well, and we find no difficulty in drying our sugars in a satisfactory manner.

The water-driven centrifugal would be more efficient, and better results could be obtained in starting and in getting a greater velocity if the water pressure carried was in proportion to the diameter of the water wheel, and the area of the nozzle was proportioned for the amount of water delivered. The pressure and area of nozzle, to give a maximum efficiency for a given set of conditions, may be found by a simple calculation. Most 40-inch centrifugals on the islands have 20-inch diameter water wheels, and the amount of water required per machine is about 1 U. S. gallon per second. We will use this for our data.

A Pelton water wheel, to work at its maximum efficiency, should revolve so that the linear velocity of the pitch-circle of the buckets is half the spouting velocity of the jet. The circumference of a 20-inch wheel is 5.235 feet, and if the required speed of the centrifugal is to be 1,000 revolutions per minute, then the linear velocity of the buckets is 5.235x1000=5235 feet per minute. The required velocity of the jet is 5235x2=10,470 feet per minute. Reducing this to feet per second, we have 174.5 as the spouting velocity of the jet. The pressure head, to give this velocity to the jet, has to equal the height from which a body would have to fall in vacuo to acquire this velocity.

To find the height or pressure head, we use the formula $V=\sqrt{2\,g.\,h.}$, from which $h=\frac{V^2}{2g}$ where V = velocity of a falling body in feet per second, h=height in feet, and g= acceleration due to gravity=32.1.

Substituting these values in the formula, we have

$$h=\frac{174.5\text{x}174.5}{2\text{x}32.1}=474.3 \text{ feet.}$$

To reduce this to pounds per square inch, we multiply by 0.434: 474.3x0.434=205.8 pounds. This is the pressure required at the nozzle to drive the wheel at its maximum efficiency. No allowance has been made for loss by friction in the pipe line. This loss will depend on the size and design of the piping. In poorly designed piping it may exceed 50 per cent.

In one sugar factory in the islands a pressure of 225 pounds per square inch is being used, and is giving very good results.

The size of the nozzle may be found by using the formula q=a v, from which $a=\frac{q}{v}$. When a=area of nozzle in square inches, q= quantity of water per second, and v = velocity of jet in inches per second.

Assuming 1 gallon, or 231 cubic inches of water, is required to drive one centrifugal, we found the velocity at the nozzle to be 174.5 feet per second, this will have to be multiplied by 12 to reduce the velocity to inches.

Substituting these values in the formula, we have a =

$$\frac{231}{174.5\text{x}12}$$

=0.01103 square inches, or 3-8 diameter.

The best pump for this service would be a duplex outside packed plunger fly wheel pump, of compact design, fitted with cut-off valves and hydraulic governor, somewhat similar to the latest type of fly wheel vacuum pumps. An engine of this type uses steam expansively, and will require about 30 pounds of steam per indicated horse power per hour, while a direct acting pump uses from 100 to 150 pounds of steam per indicated horse power per hour. In factories where the low-grade sugars stand during the off season, and are dried before commencing milling, the saving in the cost of fuel, by the use of a fly wheel, instead of a direct acting pump, would soon repay the extra outlay.

A NEW AUTOMATIC CENTRIFUGAL INVENTED BY MESSRS. W. G. HALL AND W. A. RAMSAY, HONOLULU.

This was fully described recently in the Scientific American, from which we quote in full:

"The new type of separator for sugars and other substances offers the advantage of permitting the material to be continuously fed and distributed while the parts are rotating at high speed, thus obviating the necessity of stopping the machine to place the material therein, and saving the time and power incidental thereto. The machine provides for the thorough separation and isolation of the liquid from solid matters, and for forcing the latter positively down through the separator.

It comprises a drum rotated at high speed, within which a number of treatment cylinders are mounted, which have a slow, rotary movement on their axes. In our illustration the drum may be seen in section at 1, revealing the treatment cylinders at 2, mounted therein. The interior of the drum is provided with a number of plates or webs, two of which are secured to the shaft 3. The treatment cylinders are held loosely in openings in these webs, being supported by flanges at the top. Raceways 4 are formed along the edges of the web openings to receive rollers or balls, which bear against track bands on the cylinders and serve to diminsh the friction when the cylinders are in motion. The sheet-metal walls of the cylinders have a large number of perforations, through which the liquid is thrown by the centrifugal energy developed in the rapidly-rotating material, the solid matter being retained by the wire-screen lining of the cylinder. Each cylinder is provided with a feeder consisting of a broad strip of metal bent in the form of a helix, as shown at 5. In operation the drum is driven at a high rate of speed by any suitable motor acting on the shaft 3, and the material is fed into the cylinders by centrifugal action from a hopper 6. Owing to the high speed of rotation of the drum, the material in each cylinder will hug that part of the circumference which is furthest removed from the center, the liquid part passing out through the perforations. By a system of gearing the cylinders are made to rotate slowly on their axes, so that the spiral feeders force the solid matter downward until it passes into the stationary receptacle 7.

The liquid, in the meantime is entirely drained out, and passing through perforations in the drum, is caught in a trough at the bottom of the stationary casing 8, whence it flows out through the discharge pipe. The gearing which provides for the independent rotation of the cylinders comprises the bevel gears 9 and spur gears 10, mounted to revolve with the drum 1. These gears are caused to rotate on their own axes by means of worm gears meshing with the stationary screw or worm 11. The gears 10 engage an independent gear ring 12, which meshes with the gear on the bottom of each cylinder. It is evident that by this system of differential gearing the cylinders are made to slowly rotate while revolving about the common axis of the drum. The universal joint 13 on a stationary shaft provides for any irregularity of rotation or oscillation of the gear casting 14, which is rigidly secured to the drum, and yet has bearing on the stationary shaft of the worm.

This machine was tested by the inventors at the works of Messrs. Catton, Neill & Co., Honolulu, with very satisfactory results.

MILL MACHINERY.

In reply to a special letter re milling, etc., in Fiji and Australia, as compared with Hawaiian methods, Mr. James Steel, chief engineer of the pumping stations at Waialua, who has had many years' experience as a sugar engineer in those countries, writes as follows:

"Perhaps the most striking difference between the mill practice which I have been accustomed to in Fiji and Australia, and that prevailing at the best mills I have seen here, is in the treatment which the bagasse receives in passing from one set of rollers to the other.

"Here but little importance is attached to the diffusion of the juice in the bagasse. It is roughly drenched with water—more or less hot, but in one instance purposely kept cold—upon leaving one set of rollers, and rapidly conveyed to the next set, the time between leaving one set and entering the next generally not exceeding one and one-half minutes. Under these circumstances the least possible amount of diffusion takes place in the bagasse, and for the extraction of the juice the sheer force of the grinding is depended on, and nothing else.

"Now in Australia and Fiji, the practice in the best factories is radically different. Instead of the mills being set close together with the shortest of conveyors between them, and all geared to one engine, the mills are set with long distances between them, and each is driven by a separate engine. Long, capacious conveyors extend from one set to the other, in which the bagasse is conveyed very slowly through a bath of boiling water—or, preferably, of the weak juice, as expressed by the last set of rollers. In this way the bagasse is immersed in a hot bath for a period of from ten to twelve minutes between one grinding and the next. During this period a very material diffusion takes place between the juice in the cells of the bagasse and the water with which it is saturated. The value of this action will be evident when I mention that with a shredder, two 3-roller mills and a diffusion carrier, it is quite usual to obtain a higher extraction than is obtained here with a 9-roller mill and preliminary crusher.

This superior extraction is due mainly to the diffusion of the bagasse. That there is a great deal to be gained under any circumstances by the diffusion of the bagasse, the following considerations will show:

If you refer to your laboratory records and compare the per cent. of sugar in the bagasse, leaving your last set of rollers with that in the juice which was expressed from it, you will find that there is not very much difference. That is to say, suppose the bagasse contained 4 per cent. of sugar, the per cent. of sugar in the juice expressed may range from 3.75 to 4.5 per cent. At first sight this may appear satisfactory, because the juice expressed contains as much sugar as the bagasse, and it may appear that more sugar could not be extracted without more water. But let us look at the per cent. of water in the bagasse, which contained, say, 45 per cent. Now the bagasse contained 4 per cent. sugar, but it is certain that all of this was in solution in the 45 per cent. of water which it contained. The water, then, which was left in the bagasse contained $\frac{4 \times 100}{45} = 8.88$ per cent. of sugar, while that expressed contained only 3.75 to 4.5 per cent. It is evident that the only way to get at this sugar left in the bagasse is by diffusion. If time could be allowed for complete diffusion to take place between the water of maceration and the juice in the cells of the bagasse, then the water left in the bagasse would contain the same per cent. of sugar as that expressed. Suppose the juice expressed contained 5 per cent. of sugar and the bagasse 45 per cent. of water, then the sugar left in it would be only $\frac{5 \times 45}{100} = 2.25$ per cent., or 1.75 less than without the diffusion treatment. Of course this figure is not obtained in actual practice, but a fair approximation towards it is made.

The system in use at some of the mills here of using the juice from the third set of rollers for maceration behind the first set is an excellent one. It might be improved upon, however. In Australia and Fiji, instead of taking the whole juice from the last set of rollers, a high trough is fixed in front of the last mill, and the juice expressed by the first rough squeeze of the rollers is caught by it and returned for maceration. This is of a lower density than the average of the whole juice expressed, and so is more efficient for maceration purposes.

There is an advantage which the system of having a separate engine for each set of rollers has over that of driving with one engine, and that is, that the speed of each set can be separately regulated. Against this it is claimed that the hydraulic gear compensates for all variations in the amount of feed; but it should not be lost sight of that the time during which the bagasse is under pressure is a most important factor in determining the degree of extraction. Here it is the general practice, when all three sets of rollers are geared to one engine, to have each set of rollers geared to run slightly faster than the preceding one, this being done to insure that the second and third mills may keep clear with their feed. In Australia and Fiji the second and third mills always run more slowly than the first. They are fiitted with force feeders, which act with great efficiency, so that the only limit to the amount that can be put through at a given speed is the power of the engine to drive it. It is a common thing to see the mills pull up with the heavy feed. Indeed, unless the mills pull up a few times each day, they are not considered to be doing their best work. The engines being fitted with link-reversing gear, there is no trouble in handling them when they do pull up.

Regarding the treatment of the juice, there is but little to be said by way of comparison, the treatment being according to standard methods in both instances.

There is an interesting feature of the work of the evaporators in Australian mills which may be mentioned, and that is that where quadruple or quintuple evaporators are used, the first vessel is worked under a pressure of from 3 to 4 pounds to the square inch, and from this, besides supplying steam to the rest of the train of vessels, steam is also drawn for general heating purposes, such as heating the maceration water and baths of diffusion carries, foul juice going to press filters and the preliminary heaters for the juice before clarification. It is also becoming the practice to dispense with the usual steam traps for the condensed water from the evaporators, their place being taken by a receiver, from which the water is pumped direct back to the boilers, without ever being released from the pressure under which it is condensed, in just the same way as we do with the condensed water from the steam jackets of the engines at the best pumping stations here.

Regarding the final drying of the sugar before packing, instead of using the air driers which are coming into use here, a system of steaming the sugar while in the centrifugals is in vogue. This has the advantage over the air-drying process, in that, besides drying the sugar, it cleans and purifies it, and that the volume of the sugar for a given weight is not increased as in the case of the air-drying process.

It is interesting to note that, while here the sand filter is coming into use for the final clearing of the juice before concentration, in Australia and Fiji bagasse filters are used for this purpose. The bagasse used is just as it is delivered from the last set of rollers, and when it is removed from the filters it is passed through the rollers again. The filters usually consist of square tanks, with suitable arrangements for charging and removing the bagasse. The juice enters at the bottom and rising through the bagasse, overflows at the top. I must say, however, that having seen both systems at work, the sand filters appear to me to be preferable.

CLARIFICATION MACHINERY AT THE McBRYDE SUGAR CO.'S MILL; DESCRIBING ITS OPERATION.

The system of clarification at this mill is quite a revolution from the older methods, and is accomplished at the rollers during the extraction of the juice. The machinery consists of the usual lime-slacking vats, a mixer fitted with stirrers, a circulating pump, lines of 4-inch piping to the mills and back to the mixer, distributing trough across the carrier behind the first mill, with the necessary valves and fittings, a sulphurizer and juice heater, circular defecating tanks fitted with copper coils, the usual storage and liming tanks for the scums and mud, with filter presses, pumps, etc.

I am indebted to Mr. James W. Donald, the chemist and head sugar-boiler of the factory, who has had two years' experience with this clarification system, for the following interesting description of the working of this machinery.

The operation is as follows:

The lime is slacked and immediately made up with water until the thick milk of lime contains 2 pounds of lime per gallon (about 24 deg. Beaumé), and this is the stock mixture from which is perpared the very dilute "milk" used on the cane. The mixer is filled to the working height with water, and the stirrer set in motion. The lime mixture is then poured into it until the milk of lime, thus produced; just begins to give a reading on the Beaumé spindle. The circulating pump is now started, the water opened so that a steady stream flows into the mixer, the attendant adds small portions of the strong lime mixture at short intervals, the valve at the distributing pipe is opened as much as required, and the whole apparatus is then in operation. Very dilute milk of lime is thus scattered on the bagasse as soon as the latter leaves the first mill, and it takes the place of the usual first mill maceration water, whose function it also performs. Water is sprayed on the second mill bagasse as usual. The juices which are expressed at the second and third mills are heavily overlimed, but they meet and mix at the strainer with the first mill juice, which is the normal cane juice, and the quantity of lime applied is so regulated that the mixer juice flowing into the receiving tank is slightly alkaline. An attendant is posted there, and makes continual tests of the reaction of the mill juice, increasing or decreasing the amount of lime as the test indicates. This adjustment is effected in either of two ways. The valve at the first mill sprayer may be opened or closed a little, thus altering the volume of lime water applied, or the quantity of lime mixture run into the mixer may be manipulated so as to give a lime water of the proper strength. The latter is the method followed here, so as to avoid continual alteration of the degree of maceration.

From the receiving tank the juice is pumped to the top of a sulphur-tower, down which it flows in a zigzag fashion over a series of shelves, and encounters sulphurous acid fumes traveling up the tower from a burner beneath. It is taken by a pump from the bottom of the sulphur-tower and sent through a juice heater (where it is heated to 190 deg. or 200 deg. F.) to the defecating tanks. In ordinary work the sulphur-tower is not used, and the juice is pumped directly from the receiving tank to the refecators; but when grinding cane of poor quality, the juice is overlimed and then sulphured, the sulphurous acid neutralizing the excess of lime, besides effecting an additional clarification and improving the color of the juice. In the defecating tanks the juice is brought to the proper temperature and allowed to settle, when the clear juice is drawn off direct to the evaporators and the scums to the filter presses.

The work of the filter presses being so intimately connected with the clarification, will be described here. The mud is heated, limed, and pumped into the presses in the usual manner, but *without any dilution* other than that necessary in washing out the defecators. No press is shut off until it is as full as it can possibly be and the juice has practically stopped running. When this point is reached the supply is shut off, and hot water (condensed water from the evaporators) is forced through the cake. The water passes through very slowly at first, but it gradually runs faster until quite a stream comes from the cocks. In the receiving troughs are two plugs, one stopping a pipe which goes to the evaporators, and the other stopping a pipe which goes to the lime-water mixer. The first is left open during the filtering of the mud and durin the early part of the washing, but when the density of the washing has gone down to Beaumé 1 deg. or less (cold), it is replaced and the other plug withdrawn. The wash water is thus conducted to the liming apparatus, and this is the water which is used in the liming operation at the first mill. The juice between the particles of mudcake is driven out by the hot water in a very short time, half an hour being sufficient to bring the washings down to 1 deg. Beaumé, so that there is very little dilution of the juice and very little extra work for the evaporators. But the last traces of sugar within the particles of mudcake cling to them very persistently, and it is indeed impossible in practice to completely free the cake from sugar. The washing is therefore continued as long as the capacity of the filter press room and the requirements of the liming room will allow, and that is twelve hours in this factory for each press. After the twelve hours' washing, the mudcake is subjected to three hours' steaming in the press, the small quantity of washings from this operation being also taken to the lime mixer; the press is then opened up and the cake dropped. Our mudcake comes from the presses in good, firm slabs (frequently as hard as wood), and contains on an average 2.75 per cent. of sugar, with a minimum of 1 per cent. and a maximum of 3 1-2 per cent. The variation of between 1 and 3 1-2 per cent. depends upon the amount of maceration water required, and with a continual high maceration the average will more nearly approach the lower figure.

For the clarification and filteration of our juice there are seven men in all employed on each shift, two at the liming apparatus (of whom the head man has probably the most important work in the factory), two at the defecators, and three at the filter presses, who perform *all* of the work in their department, including the cleaning of the cloth and the changing of the mudcars.

The superiority of the clarification method in use here over the older methods is shown in the following improved results:

Fermentation is arrested almost at the moment the cane enters the mill. A better control of the tempering obtains, and a juice of uniform alkalinity is sent into the boiling house. Frequent checks and changing of weights and measures by the skilled overseer are rendered unnecessary, as an intelligent Japanese, after a month or two of experience, can temper the juice better than the overseer could. This is an immensely important point in a mill which is grinding cane from several different fields at the same time, and where no ten cars are alike. As a matter of fact, the quality of the juice is continually changing, even from the same field, and a system of liming like this one, which can be regulated to correct a single car of cane and deliver to the boiling house a uniformly tempered juice which scarcely varies from Monday morning to Saturday night, is a boon. Even in cases of accident or carelessness, the juice can still be corrected at the defecators before it reaches "cracking" point—a proceeding which is not possible where a super-heater is used. The settling of the mud is very rapid. The juice arrives at the defecators at a temperature a few degrees below that of defecation one minute after the tank is full, clarification is complete, *in 5 to 10 minutes more settling is complete,* and the clear juice is being run off to the evaporator supply tank. Of thin juice there is never more in the house at one time than 5,000 U. S. gallons, and this includes unfiltered mud and every process before evaporation. Thirty minutes after the mills finish grinding the clarifiers are empty; in fifteen minutes more all the mud is cleaned up, and thirty to sixty minutes later there is no sugar liquor in the factory thinner than syrup of Beaumé 27 deg.

The quantity of mud per ton of cane is small, being about 45 per cent. less than the average of other mills, and it is owing to this fact that we can devote fifteen hours or more to the de-sugarizing of each press full of cake. The economy of the system of prolonged washing is evident. Besides saving what traces of entrainment sugar may be in the water, the loss in mudcake is reduced to an almost negligible quantity, and these results are reached without employing any extra labor, and with very little extra work for the evaporators.

The explanation of these facts is very easy to trace. By the hot liming of the bagasse a partial purification of the juice still to be expressed takes place within the cells of the cane. Those cells act as filters, and retain the impurities in a manner identical with that of the diffusion process. Unlike the diffusion process, however, a large proportion of the juice is extracted before the lime is applied, and in addition to this the cane cells are ruptured more or less completely, and a quantity of finely divided solid matter is carried away by the juice. With a milling plant, therefore, we cannot do away with the mudcake entirely. But with a "crusher" and re-absorption of the juice before the cane enters the first mill, the liming could be so arranged that the "mud" would practically consist of nothing but finely divided bagasse, sand and soil.

In regard to the settling of the mud, it will be noticed that the hot juices which come from super-heaters make no foam (or scum) in the settling tanks; the feculant matters settle to the bottom, leaving the clear liquor on top. The reason for this is that the air and other gases which were dissolved in the juice have been expelled at the high temperature existing in the super-heater, and the mud has to depend on its own superior density to get clear of the liquid. Now, the specific gravity of the mud as it exists in the juice is about 1.176

water=1), while that of the juice itself is 1.060 to 1.070, and where there is such a small difference the subsiding of the mud is necessarily slow, more especially when it is in a very fine state. On the other hand, in the method described above, the temperature in the juice heater is kept near to the boiling point of the juice, so as to economize time and steam at the clarifiers, but far enough below it to avoid the possibility of premature boiling. In this way the hot juice arrives at the defecating tanks with all its original gases in solution, and when a tank is full, boiler steam is turned into the coils and completes the operation in a minute. The tiny air bubbles rise from every part of the liquor and carry with them to the surface all the suspended impurities. The "settling" is thus almost instantaneous, and only a few more minutes are required to allow soil and grit to subside. As already pointed out, a very large proportion of the albuminous matters of the cane do not enter the boiling house at all, and that is another important factor in the rapidity of clarification and also in the satisfactory washing of the presscake.

EVAPORATORS.

The exaporators installed in the McBryde factory supply most of the conditions necessary for efficient work. Thus, in addition to steam pressure and regularity of steam supply, the following are important factors in good evaporator work:

1. The resistance offered by the heating surface to the transmission of heat should be small.
2. The depth of juice in the vessel should be as small as possible.
3. The surface of the liquid from which the vapors escape should be large.
4. The vapor pipes to the heating drum of the next vessel or to the condenser can scarcely be too large, and should be as short and direct as possible.
5. The heat should be distributed equally over the whole heating surface.
6. The circulation should be good.
7. The condenser and vacuum pump should be of sufficient capacity and of good design.

To satisfy the first condition the tubes should be of copper, and as light as is consistent with durability; an excessive, amount of oil in the steam must be avoided; means must be provided for the rapid withdrawal of water of condensation, air and gases from the calandria; scale is an ever present (and seemingly unavoidable) evil. This and the other conditions which are now accepted by most engineers are met in a multitude of different ways, as seen in the many different designs of evaporators. "Efficiency" of the heating surface, however, does not necessarily mean economy—except in first cost. Multiplicity and complication of parts, large entrainment, liability to scaling and difficulty in cleaning, with the consequent large accounts for repairs and attendance, are sometimes the price paid for efficiency. In choosing evaporators, therefore, it is advisable to consider whether economy in the investment (which is all that "efficiency" amounts to) or economy in the working expense will give the best returns; where both are combined we have, of coure, the ideal evaporator.

The film evaporators come nearest perfection as regards the second, third and sixth conditions mentioned above, but they have drawbacks in practical use which to some extent counteract those advantages. The third condition is an important factor in the prevention of entrainment, as well as in efficiency, and is met in the evaporators installed here by keeping the juice from combining in one mass on the upper tube plate.

The tubes act as fountains, throwing the juice up in distinct and separate streams to a height of 12 to 18 inches, and these streams only combine when evaporation in that vessel is complete and the juice is leaving it. To show the effect of scaling on the work of these evaporators an actual week's work is here inserted:

APRIL, 1903	20th	21st	22nd	23rd	24th	25th
Total hours run	20	21½	2?¾	22	22½	20
" gals. clarified juice	145,270.	151240.	161,190.	151,240.	149,250.	47,757.
" " wash water	2,905.	3,025.	3,224	3,025.	2,985.	2,955.
Density clarified juice	17.53	17.15	17.20	17 50	17.95	17.55
" syrup	55.4	55.2	54.8	52.8	53.1	48.8
Average steam pressure, lbs.	5.	5.	5.	6.	7.	8.
Juice per hour—gallons	7,263 5	7,034.7	7,085.3	6,874 5	6333.3	7,387.8
Wash water per hour—gallons	145.0	140.7	141.3	137.	132 6	142.7
Evaporation, per cent. (by weight)	68.3	68 9	68.6	66.8	66.2	64.0
Water evaporated, lbs	44,063.8	43,375.	43,510 8	41,145.	39,610.2	43,405.1
Lbs. water evaporated per sq. foot of heating surface per hour	8 39	8.26	8 29	7.84	7.55	8.26

With the exception of the fourth and fifth days, the work for the whole week is practically uniform, and the falling off on those two days was due as much to the irregular supply of juice as to the fouling of the tubes. It will be noticed that the quantities of juice per hour for those two days are the smallest for the week, and also that the water evaporated per square foot of heating surface is (roughly) directly proportional to the quantity of juice worked.

The scale in the first two vessels consists principally of carbonate of lime and organic matter; the lime is removed without difficulty by boiling with dilute muriatic acid, leaving the organic matter as a soft slime which can be rubbed off by cloth swabs. The scale in the third vessel consists mainly of silica, and is more troublesome, but it is partly dissolved and the residue left softer by treatment with caustic soda solution, after which it is easily removed by brass-wire brushes.

The work of the evaporators at the McBryde mill for the whole of 1903 crop is appended:

Total hours run	2,802
Total gallons clarified juice	18,329,978
Total gallons wash water added	366,599
Average density of clarified juice, Brix	16.71
Average density of syrup, Brix	55.34
Average steam pressure, lbs	6
Gallons of juice per hour	6,542
Gallons of wash water per hour	131
Per cent. of evaporation by weight	69.8
Total water evaporated per hour, lbs	41,673
Total heating surface of evaporator, sq. ft	5,248.8
Lbs. water evaporated per sq. ft. per hour	7.93

The diagram attached to this paper is a graphical record of the work done by a Lillie Quadruple Effect, during periods, as indicated in the diagram. It also shows the conditions, which existed during those periods.

The record of conditions is represnted by broken lines, each point in the broken lines being located in regard to time and pressures.

Looking at the diagram, there will be seen in the left vertical line, the spaces for pressures. Upward of the atmospheric line (°) are spaced off, the lbs. per square inch of steam pressure effective in steam chamber of first cell, and each lb. of pressure is taken to be equal to 2″ of vacuum.

The horizontal line over the diagram, shows the time when the readings were taken. Another line will be seen, composed of vertical and horizontal parts only: the figures written on the horizontal lines show the rate of work, i. e., the number of U. S. Gallons that would have been evaporated to 75%, if this condition had been maintained for 24 hours.

The lower broken line represents the steam pressure per square inch in steam chamber of first cell.

The second line represents the vacuum (or pressure) in juice space of first cell, also, the vacuum (or pressure) in steam pipe of 2nd cell, the two spaces being connected.

The third line represents the vacuum in front vapor space of second cell. The fourth line represents the vacuum in front vapor space in 3rd cell, etc., etc.

The fifth line respresents the vacuum in front vapor space in fourth cell: this space is in connection with condenser.

Examining the record lines and comparing the condition of different periods, quite a difference will be noticed, the reoccurring rise and fall of the rateline is due to the apparatus having been worked either forward or backward.

The periods when the apparatus worked forward (that is, when the juice entered the first or hottest cell and syrup was taken from last or coldest cell) show a higher rate than when the apparatus worked backward (that is, when the juice entered the fourth or coldest cell, and the syrup was taken from the first or hottest cell.)

When the apparatus is worked forward, the difference of vacuum (or pressures) in steam chamber and front vapor space of each cell are nearer the ideal conditions than when the apparatus is worked backward, besides this, it is deprived of a considerable amount of heat when the syrup is drawn from the first or hottest cell.

Looking at the whole rateline, it will be seen that the drop in capacity is almost constant from the beginning of the week to the end. There is absolutely no doubt that this drop of efficiency is due to the fouling of the heating surface in the apparatus. Evaporators of the same type and size give vastly different results in different places, when the condition of the juices are not alike. The authentic records show this plainly: all those apparatuses which keep clean easily perform their predetermined work, while those which from the nature of the juice have their heating surface coated, and often quite heavily, drop rapidly in their capacity.

The diagram in the upper part of the sheet contains the record of a full week's run, while the diagram in the lower part of the sheet contains the record of the first 24 hours only, of the following week.

In comparing the record of this one day's run with the corresponding one of the week before, some very interesting points are shown.

When the full week's run was made the connections on the apparatus were so, that the condensed steam from steam chamber of first cell was led off (as usual) to the hotwell, to be used as boiler feed water: by this arrangement, the apparatus was deprived of quite a considerable amount of heat reducing the capacity of the apparatus.

For the next week's run, the connections were made so, that this water was led into the steam chamber of the second cell, giving the apparatus the benefit of this heat in the second cell, and increasing the temperature in first cell, and thereby doing more work.

The natural inference would be, that the apparatus would do as much more work in proportion, as there was heat added, and the first few hours' run show, that this was really the case. At the end of the 24 hours, the capacity had dropped to such a low figure, that the connections were changed, to what they were in the first week's run, which was theoretically wrong, but from a practical standpoint right.

It would be impossible to give an explanation of this phenomena, if we did not examine the nature of the juice and its impurities, and how it was effected by the increase of heat in first cell.

If it is true that heat will coagulate the albumens contained in cane juices, and, that the coagulation depends on the degree of heat and the time that this heat is applied, then it must be true that if the process of heating the juice (as well as mechanically cleaning by precipitation or filteration, or both) has not been done thoroughly before the juice enters the evaporator, then this process goes on in the first and hottest cells of the evaporator, whereat the temperature may be considerably above 212° F. and where the juice is exposed for quite a while to this heat action.

The only remedy to keep an evaporator comparatively clean where the juice contains impurities that may be precipitated by heat, is to expose the juice to a proper degree of heat, and cleaning same *before* it enters the apparatus.

The proper degree of heat must be determined for each case, but should never be less than the temperature of the first cell of the evaporator.

While this run was made with the "Lillie" and the facts contained in the diagram show plainly that the decrease of efficiency is due to the fouling of the heating surface by impurities precipitated from the juice, it would be unreasonable to think that any other type of evaporator would not have been affected if worked under the same conditions.

To get reliable figures, comparing one type of apparatus with another, it is necessary to have them work under the same conditions.

SUGAR DRYING MACHINES.

These driers have been introduced into a number of our factories of late and are considered by those who use them to be a good investment. They will doubtless be of more value to us in future owing to the fact that all sugars have to be shipped to Eastern markets. A brief description therefore, of this apparatus may be of interest:

A sugar drying machine consists of an air-heater, a revolving cylinder, and a fan for drawing the heated air through the cylinder. The sugar as it comes from the centrifugals, is taken up by a bucket elevator to a hopper in which revolve a number of knives where all lumps are broken up, and is then fed through a spout into the cylinder drier. The latter is inclined from the end where the fan is situated (and where the sugar enters) downwards to the delivery end where the group of air heating coils are set; it contains a number of narrow shelves which carry the sugar round and allow it to fall in showers through the current of hot air. The hot, dry sugar is taken from the apparatus by another elevator to a revolving sifter or screen which separates the sugar into different grades or sizes of grain and delivers it through chutes into bags. The whole operation is automatic and requires no attention except at starting and stopping. It can be regulated to deliver the sugar at any degree of dryness. It could be modified, however, so as to reduce its initial cost by dispensing with the sifting apparatus which is unnecessary in raw sugar factories; and if the arrangement of the factory will allow, the elevators may also be dispensed with and the sugar travel by gravity.

These sugar driers make possible the use of automatic weighing machines in raw sugar factories. Most of these machines depend for their accuracy on a very small stream of the material toward the end of the weighing operation; ordinary moist sugar is lumpy and coherent, and there would be great difficulty in getting such a stream to flow. But with dried sugar there would be no such difficulty; and automatic scales are largely used in refineries for weighing granulated sugar. There are a great many makes of automatic weighers and it is unnecessary to mention any particular one, but there is a machine on the market which calls for special notice. It will weigh, fill, sew, and throw out ready for shipment 75 bags of sugar per hour with one man and a boy (or woman) as attendants. The bags may be delivered to a conveyor and carried right to the car, thereby saving much handling and floor space. There is a saving in twine and the bags are sewn in such a way that they are practically sealed.

WATER MEASURING MACHINE.

I am indebted to Mr. L. L. Mann, the civil engineer at the McBryde plantation, for the following article and sketch of his water measuring machine: After considering some of the methods in use at different places, their initial cost, etc., the writer proceeded to design a cheap and reliable registering device to be used in connection with an ordinary weir. As a result the apparatus described below has been in successful operation in one of our main waterways since January 1st, 1903.

While this machine does not differ widely from those in use on different plantations, it has the advantage of being inexpensive, simple to construct, and accurate enough for all practical purposes. Like other appliances of a similar nature, it requires an ordinary weir, together with a small housing to protect the mechanism from the weather.

Briefly, the principle of this apparatus is as follows:

About six feet above the weir, and directly over the stream, a small weather-proof house is built, say 4x5 feet inside floor space and high enough to permit a man to stand erect. At one side is placed a suitable table to carry the mechanism. On top of this table two parallel strips of iron (a) are fastened to serve as a track. Between these strips a planed board, 14″ wide, 18″ long and 1″ thick is placed on which may be fastened a sheet of paper ruled to indicate the actual depth of water flowing up to a depth of 18″ along the axis of ordinates, while time is ruled along the axis of abscissas to any suitable scale. A light carriage (b) having four small wheels is made to run upon the track (a). This carriage bears a small lightly pivoted shaft, threaded throughout its length, on which there runs a nut as the shaft revolves, and to the upper part of which a pencil is attached. To one edge of the carriage (b) and running over a light pulley at the end of the table a cord (c) is attached carrying a float (d). To the opposite edge a similar cord (e) is attached carrying a weight (f) and these are so adjusted as to bring the pencil point to zero inches of depth when no water is flowing over the weir. With this arrangement the depth of water is registered on the above mentioned sheet as the flow of water over the weir rises or falls. To one end of the shaft (g) a disc (j) is attached around the circumference of which a number of small studs (k) are placed to serve as stops. The number of stops depends upon the pitch of thread of shaft (g), upon the interval of time for which the machine is designed to run without attention, upon the scale to which record sheet is ruled, etc. To the disc (j) a small crank or handle (l) is attached for the purpose of rotating the shaft (g) so as to bring the nut and pencil to the hour when the apparatus is to be put in operation. Arranged so as to engage the studs (k) on disc (j) is a stop (m) pivoted to the end of the armature of an electro magnet (n) which is placed in circuit with an ordinary clock (o) and a couple of Samson batteries (p.p.) To the face of the clock (o) small clips are fastened, at intervals of five minutes, which engage the minute hand of the clock in passing: closing the battery circuit, which in turn operates the magnet thereby withdrawing stop (m) and allowing the shaft (g) to rotate under the influence of the weight (i) carrying the nut and pencil forward to a point on the record sheet corresponding to the time indicated by clock (o) thus tracing a zig zag line as the flow water increases or diminishes, and thus giving the true depth of water flowing over the weir at intervals of five minutes, which is sufficiently frequent for all practical purposes. By reference to a weir table the cubic feet or gallons of water flowing for any given interval of time may be ascertained.

This apparatus requires attention once every 24 hours but could be as readily designed to operate for any given length of time for which a clock might be designed to run without attention. Its chief merit is its reliability and cheapness. The weight (i) being the motive power the work of the electro magnet and clock is reduced to a minimumu. The clock, so wired as to be set with two contact points upon two respective contact plates, is entirely independent of the rest of the mechanism, and may be substituted by a similar clock at a moment's notice. The batteries will require recharging at intervals of from 3 to 4 months, at a cost of about 25c. The cost of this recording device complete with weir and housing does not exceed $30.00.

PUMPS AND PUMPING.

I have no data on hand to enable me to put before you the comparative cost of pumping water per million foot gallons with the many different styles of irrigating pumps and the actual saving which has been effected by the use of oil fuel in place of coal: This would also be interesting and of value to many of us and I would therefore suggest, that some steps be taken to put this data before us at your annual meetings.

I submit herewith a monthly report form in use on this plantation which can be filled out in the main office each month from the pump engineer's daily reports.

The average cost of pumping water per million foot gallons on this plantation with three different styles of pumping engines, including all labor, supervision, coal, supplies and repairs, during the running season is as follows:

Risdon 10 million surface condensing, triple expansion, flywheel pump with Heine water tube boilers and economizer $0.0448 per million foot gallons.

Riedler 10 million surface condensing, triple expansion flywheel pump with Babcock and Wilcox water tube boilers, no economizer, $0.0465 per million foot gallons.

Worthington 6 million, surface condensing, 4 cylinder, triple expansion vertical pump with Sterling water tube boilers, no economizer, $0.0705 per million foot gallons.

Respectfully submitted,

WM. STODART.

Elm Row, Selkirk, 1st Oct., 1903.

William Stodart, Esq.:—

Dear Sir:—Dealing with the other matters mentioned in your letter after Centrifugals. I will touch but lightly on a few points which come under my own personal experience and which I hope may prove of some little interest to you.

KILBY PANS.

I must frankly admit that I never was enamoured of these pans and so far as my experience at Kealia went, the more I saw of them the less I liked them. My chief objections to them lay in the drainage of the coils; the size, length and disposition of the coils; the height of the pans, and the want of facilities for repairs to the coils.

These pans were provided with 19 coils, 2 1-2 inches in diameter, the bulk of those above the tapered bottom, being about 126 ft. long. Their drainage gave trouble from the first, especially the live steam drainage. Concluding that the uncondensed drainage from the short lower coils was retarding the water from the long upper ones, we separated them and stopped the trouble. Coils of such size and length as these long ones, and lying almost flat as they do can not in my opinion do very effective work, and I firmly believe that about half of the heating surface is of little or no effect. The coils are so closely grouped together, that a man cannot get between them for cleaning and repairs. I had some of the coils to repair in the middle of the pan, and it was a very serious operation even in the off season. We seldom filled them full as the work became too slow, neither did we care to boil heavy. With syrup of from 30 degrees to 35 degrees B., the work was passable, but with light syrup, it was painfully slow. The swinging discharge gate on the bottom, made cutting strikes almost impossible.

SAND FILTERS.

In mills where super-heating and single settling of juices is carried out, and the evaporating plant is of ample size, sand Filters are in my opinion, but cumberers of space. Those at Kealia, filter certainly, with the aid of a hoe, but—is the game worth the candle? I believe that single settling there, would entirely eliminate their use, as far as juices are concerned.

EVAPORATOR.

The Wellner Jelinek at Kealia has done very well, but that I think is mainly due to its size—12000 ft of heating surface. The entrainment at first, was, I understand, considerable, but with the addition of baffles and catch-alls, and alterations in the feed pipes, I believe all loss by entrainment has been stopped. From what I have been able to learn from other mills and experiences in the Islands, a good Standard Effect—

with the necessary precautions against entrainment—is about as economical, safe and reliable as anything which has yet been tried.

NINE ROLLER MILL.

Touching first on Roller Setting. I am convinced that—under some misapprehension—considerable nonsense has been written and spoken on this subject. I had four "Roller Settings" from different sources, each of which was given by its author as "the correct thing." All were different, and for reasons which I will try and show, necessarily so; and further, all were wrong; that is, so far as their application to my case was concerned. There is not, nor can be, any hard and fast set of measurements put down as "the correct thing" for roller setting. Differences of canes, weather, lands, locations of plantations, seasons, exigencies of managers and conditions of labour; all of these may and do—more or less—affect roller setting. About all that can be said of roller setting in a general way is, that it should be such as will ensure that each set of rollers will cope with and treat the cane supplied to them, in such fashion, that a reasonable percentage of the juice is extracted by each mill; that the bagasse is sufficiently lacerated or broken up in a proportionate degree as it leaves each mill, emerging finally in such condition as has been deemed most serviceable and economical for fuel. So long as this is being accomplished, and each mill is *just able* to take the supply of bagasse from the preceeding one without choking, just so long, in my opinion is the roller setting right. I have found it necessary to alter the setting at Kealia several times in a season. Of course a reasonable pressure in conjunction is always implied. The relative speeds of the mills is another subject, and is, of course, governed by the gearing supplied with them.

QUALITY OF ROLLERS.

The quality of the rollers demand careful attention. At Kealia I found that the softer rollers were the first to become slack on the shafts. I think it may safely be said in a general way,—that the softer the roller, the sooner will it become slack on the shaft; the sooner by attrition in the ordinary course of work, will the grooves disappear; the sooner and oftener will the wheel teeth require chipping, and the sooner will the roller have to be renewed. Further, if the roller is more compressible than its shafts and keys, it will the more readily become slack and at liberty to move endwise. Again if the roller is less compressible than its shaft and keys, it may become slack on the shaft, but will not be so liable to move endwise, as the remainder of the shaft would maintain its original size and present a slight shoulder against the end movement.

A roller and shaft in one piece, such as a single casting, has been spoken of, and the idea carries with it much to commend itself, but until a metal or compound has been found combining all that is necessary in a roller and a roller journal, it is futile to discuss it further at present. To successfully cope with the endwise movement in rollers, and its accompanying dangers, I would suggest, that when a shaft has been designed, of sufficient size for the work for which it is intended, another inch or inch and a half should be added to its diameter, where it passes through the roller. After the roller is pressed on, this would allow of cutting in each end, for good, split and shrunk rings without unduly weakening the shaft.

WATER-JACKETED BEARINGS.

All Roller Mills should be supplied with water-jacketed bearings, more especially where their care and lubrication is mainly entrusted to lowclass labor. I don't for a moment say that water-jacketing will prevent all heating and cutting of bearings, but it will lessen the chances and often make it possible to keep a mill running, when it would be otherwise impossible without injury. A simple illustration will suffice.

No roller journal, however perfectly turned, has at first a perfect contact with its bearing. It is well bedded in place if 50 per cent. of the bearing area of each,—well distributed,—is in contact. If a bearing area of say 100 sq. inches is deemed necessary to carry a given load, it must necessarily follow that the same load imposed on 50 sq. inches of area will generate heat. It is at this time then—when a mill is new—that waterjacketing is of greatest value, because if the full bearing area can be brought up without cutting, the after saving in oil and trouble is invaluable. Further, if it becomes necessary to cool a bearing without stopping the mill, the water is turned on through the jacketing, and the oil or grease applied to the journal. If no water-jacketing is existent, the hose is applied to the journal and the oil by the same operation is washed off. The result is too apparent to merit further discussion. With water-jacketing and good bearings, it will be found that a lower and cheaper grade of oil may be used than might otherwise be possible.

MACERATION.

Returning third mill juice was tried at Kealia last season, with what results I am not just prepared to state. From an engineers' point of view it is an improvement, as it helps to keep the rollers clean and improves the feed. As to its economic value in increasing the extraction, I have never been able to see the philosophy of it. However, if it can be proved to increase the extraction we can afford to do without the explanation; still I would like to see a logical reason given.

I believe that Maceration when applied on mills such as those in Hawaii, should be pumped on under considerable pressure. With the object of testing this idea, we connected the Maceration pipe with a pump, and introduced an adjustable relief value in the line. To obviate all chance of throttling or reducing the pressure with valves or cocks, we put in three small pipes in place of the one formerly in use, with a cock on each. If say 10 per cent. Maceration is wanted, open one pipe full open; if say 20 per cent. is wanted, open two pipes full open, and so on, making each pipe roughly represent any percentage desired. Further, we introduced another small pipe at the bottom edge of the scraper to force water through the trash blanket from below. The result is a thoroughly saturated trash, to the amount desired. To suit the pipes to the needs of each particular establishment is a simple matter of adjustment. We pumped on the water under 50 or 60 lbs. pressure. We also tried hot and cold water. I think the most satisfactory temperature is from 100 degrees to 120 degrees F. Very hot water is liable to heat unduly the rollers and journals.

CANE UNLOADER.

Of cane unloaders, that at Kealia is the best I have seen. It is a Froelich machine, adjusted to lines which we considered would give the most satisfactory results. These we obtained, and to operate it, is child's play. With a widening apron over the cane carrier, the load can be laid on very evenly. It can easily handle 1000 tons of cane per 24 hours, and only one machine is necessary for a nine roller mill of any size.

I am, yours most resp'y,

JNO. ANDERSON.

W. Stodart, Esq.,

Dear Sir:—I am afraid I can be of very little assistance to you in your report on machinery. I know of very little in the line of improvements or new devices introduced within the past year, or that has not already been brought to the notice of the Association in previous reports. However, as you suggest a description of the automatic firing arrangement in use at Hakalau as being of possible interest, I submit, even at the risk of the information being characterized as stale, a brief description of same, referring in passing to recent changes in boiler setting with reference to position of furnace.

In the way of bagasse burning furnaces the trend seems to be toward a change from the old boiler setting, whereby the furnace was placed under the front end of the boiler, and a furnace, such as has been adopted by the Honolulu Iron Works in their recent installations, is replacing the old style of setting. The favorite boiler arrangement for many years on these Islands was, as you are aware, that of a multitubular and a Galloway or flue boiler, set tandem, the step-ladder furnace being situated under the former boiler from which the heated gases traversed the bottom and sides of both boilers, returning through the flues and tubes to the chimney. By this setting much of the heating surface was exposed to the comparatively low temperature evolved in the initial act of combustion. By the improved setting the furnace is built out in front of the boiler, so that the whole under surface of the boiler is exposed to the flame after it has reached its maximum temperature. Another improvement is the provision for more space between the bottom of the boiler and the flame bed, as much as four feet being allowed, instead of two feet or less, as formerly. The advantage from this increased space is twofold, as it permits of easy access for cleaning or other purposes, and what is, perhaps, of more importance, the heated gases are not forced downwards to the floor or flame bed allowing a great part of the heat to be absorbed by the earth. In 1901 we had a new 7 inch x 20 inch multitubular boiler installed by the Honolulu Iron Works, with this new furnace setting. In 1902, I changed one of our old boiler settings to conform to the new plan, which resulted in such increased efficiency that I have this year extended the change to the remaining ones. A further advantage in placing the furnace out in front of the boiler is that the bagasse chutes in connection with an automatic firing arrangement, as in our case, can discharge perpendicularly from the bagasse conveyor to the furnace, thus obviating the inward bend in the chutes necessary with the old furnace.

In nearly all sugar mills on these Islands, with any pretention to keeping in line with modern improvements, the old method of firing by hand has given place to mechanical stoking. While these automatic firing devices may differ in detail, the salient features of all are essentially the same and have already been described in former reports. The arrangement at Hakalau is as follows:

The bagasse is elevated from the last mill onto a horizontal conveyor, running overhead of the line of furnaces. This conveyor consists of an endless link-belt chain, operated by sprocket wheels, and to which are bolted at regular intervals wooden slats, which sweep the bagasse over the stationary floor of the conveyor, which is provided with adjustable openings through which the bagasse drops into iron chutes leading direct to the furnaces below. In these iron chutes are placed doors, which are tripped automatically and at regular intervals, ensuring a regular feed and preventing the access of cold air through the chutes to the furnaces. These iron chutes are movable sideways, being hung by a hanger and a rail arrangement from above, so that they can be moved aside for the purpose of cleaning the boiler tubes in front of which they stand when in position. When this arrangement was first installed about six years ago, the openings in the floor of the conveyor were cut parallel to the line of the conveyor, each opening increasing in width laterally until the last opening reached from side to side of the conveyor floor. It was found that this arrangement did not ensure an even distribution of the bagasse over the grate bars of the furnace. The openings were then changed so that they now open obliquely across the conveyor floor, each suceeding opening increasing in width, as in the former arrangement. The oblique position of the opening being such that an equal amount of bagasse is caught over its entire length, with the result that the grate surface is uniformly supplied. In addition to the main elevator driven from the mill, there is an auxiliary elevator upon which surplus bagasse can be forked in the event of the mills being stopped or when getting up steam on Monday morning. The whole arrangement is driven by a small, independent engine. The saving in labor in our case by the automatic firing device is 4 men on each shift, or 8 men per day of 24 hours, in firing four furnaces, while the work is much more efficiently done than by hand. Firing bagasse furnaces automatically is not by any means new in Hawaii, for even as far back as 21 years ago the writer saw an automatic firing device at Hawaiian Commercial & Sugar Co., on Maui. This arrangement was installed by the Risdon Iron Works of San Francisco, but proved too cumbersome and costly to come into general use. In this arrangement each furnace was provided with an independent engine and conveyor connected with a multiplicity of gearing. To Mr. J. A. Scott of the Hilo Sugar Co., the writer believes, is due the credit of first introducing the present day system of automatic firing and which was constructed from plans prepared by him, by the Risdon Iron Works. Mr. Scott was also the first to replace hand straining of the juice at the mill rollers by the mechanical device now in general use in this country.

I see that the Honolulu Iron Works have imported one of the "Simon" automatic sack-filling, weighing and recording machines, to which they invite inspection. If such a machine proves a practical success in sacking and weighing raw sugar, it should come into general use, for I think that much difficulty has been generally experienced in getting the class of labor usually employed in our sugar houses to fill sacks to a given weight accurately, to say nothing of the probable saving in labor.

I am sorry I know of nothing more likely to be of general interest.

Yours truly,

GEO. ROSS.

Papaikou, Hawaii, Nov. 10, 1903.

W. Stodart, Esq.,

Eleele, Kauai.

Dear Sir:—In reply to your letter of September 13th, I herewith beg to submit the following description of battery of crystallizers, manufactured and installed on the premises of the Onomea Sugar Company on the Island of Hawaii with plantation help from eight old cylindrical boilers, hoping that the details of construction and general assemblage of said crystallizers may be of some value to those interested in the crystallization of sugars in motion.

The space occupied by eight crystallizers (each of which is 6 ft. diam. by 12 ft. long) is 35 ft. by 40 ft., the crystallizers being set in series of fours with a ten ft. space in centre, in which space is located the Magna pump that in no way interferes with the passage way between crystallizers. These are driven from a 3 in. steel shaft overhead in mid position making 90 revolutions per minute (steam and electrically equipped) said driving shaft being supported on angle iron frame work secured by bolts to heavy railroad iron on 7 in. pipe columns. These pipes are stepped and filled with concrete, making a perfectly rigid skeleton work. Keyed to the aforesaid 3 in. steel shaft are eight 20 in. pulleys (10 in. face), one for each crystallizer, on to which runs a 4 in. rubber belt connecting with two 5 ft. pulleys, tight and loose. On the 5 ft. pulley shaft 2 11-16 diam. is also keyed the driving worm (running in oil), said worm meshing with circumferential worm gear bolted to outside of crystallizer shell. The speed of crystallizers is one revolution in 3.75 minutes.

The crystallizers are held in position and revolve on two cast iron circumferential tracks bolted to outside of crystallizer shell, being trued up by wedges. The same may be said of the circumferential worm gear which is placed midway between aforementioned iron tracks, it being understood that no weight rests on said worm (revolving thrust only). The two cast iron tracks run on eight cast iron pulleys contained in four equalizer brackets, said brackets working on a fulcrum pin, and are held from spreading by a cast iron sole plate with a right angle piece at either end into which angle sits the bracket, free to work on its fulcrum pin; by this method the possible although not probable wear can be adjusted, thereby doing away with the danger of too deeply meshing of the worm driving gear.

Interior Arrangement.—Extending the entire length of crystallizer on opposite sides are two plate supports bolted to interior of crystallizer shell braced with angle iron every four feet in such a way that the contents have a clear passage to exit and a 2½ in. space is allowed between shell and plate support to avoid trapping the mascuit; this support extends in a curved direction passing the centre and thereby avoiding any dead space. Bolted to these supports (in this case) are 150 ft. of galvanized pipe connected in such a manner that it makes one continuous pipe throughout. This pipe is put in sections connected together with ground brass unions, thereby making it possible to remove any portion for any purpose through manhole door, said door being placed at opposite end to discharge gate and on top position when discharge is on the bottom.

The aforementioned 1½ in. galv. pipe is the temperature adjusting arrangement, through which exhaust steam, hot or cold water, may be used, as it has branch connection on the outside. I enclose a sketch marked "A" which shows the method of connecting and passage through centre of crystallizer shell. This 150 ft. of pipe has sufficient surface to heat or chill to maximum temperature either way the entire contents in 2½ hours.

I should have mentioned that this battery of crystallizers are so arranged that they are charged through flumes gravitating from molasses pan and discharge into flume connected with water driven Magna pump.

Temperature.—Despite all statements to the contrary the writer has found by actual work that it is highly important that the temperature should be adjusted with great care, knowledge of which can only be acquired by local practice, to meet different conditions of cane grown in various localities. Once understood the knowledge can be easily imparted to the attendant and will work, subject to a general supervision, but the same methods will certainly not be successful in universal practice without close and intelligent observation of the material to be handled.

In regard to work accomplished by us with the aforesaid crystallizers, we feel fully satisfied that on the coming season's crop we shall be able to reduce the purity of our turnout molasses well down to its commercial limit of profit together with speed, and hope to be able to compile commercially accurate results with no guess work. I would also state that we reinstalled our mudpresses (eight in all) and in doing so introduced (as far as the writer knows) a new device by placing beneath said mudpresses for No. 1 work a 12 in. slow travelling screw conveyor, belt driven, with a planetary gear. Into casing of said 12 in. conveyor is dropped cake from No. 1 presses, likewise a continuous stream of boiling water from first bodies of triple effect into the admission end of conveyor casing and there in transit is regularly and thoroughly incorporated and delivered to vertical strainer tank in which is a revolving horizontal belt-driven paddle making 140 rev. per min., revolving in close contact with strainer in bottom of vertical tank, said tank having a continuous discharge beneath the aforesaid strainer to pump reservoir, the whole performance working automatically and requiring but little attention outside that on the part of the pump attendant.

The same installment leads from the second presser with the difference of a faster travelling screw, which embraces the essential feature in delivery, namely that of grinding to powder fully 98 per cent. of the turnout presscake; this contrivance works perfectly and all is driven from crystallizer driving shaft. The aforementioned presses are connected in fours as we do double pressing. The amount of presscake from our last crop of 13,500 tons of sugar was close to 3000 tons, therefore the grinding to powder is obviously important for fertilizing, and also the reduction (by even work) of sucrose in turnout presscake, that means dollars.

I am forwarding for inspection and criticism two models of non-fouling links designed by the writer suitable for apron conveyor that I am inclined to think will appeal to all modern mill owners and in any concern that may have occasion to use apron conveyors. The only style of links that (as far as my knowledge goes) are used in connection with apron conveyors for sugar mill work are the open and pocket link; the former has been abandoned for the latter on account of leakage but the pocket link has the disadvantage of filling up and packing with bagasse and debris in general in the sprocket hole, thereby causing the chain to lift and ride, and the apron to slip when it again starts to feed; the accumulation of bagasse on rear end comes in a bunch and if the attendant fails to be on hand the chain will stretch or ride out, or the apron will commit suicide and go through the mill, this apart from the fact of irregular feed which is the reverse of good work. On those grounds and many others that can be noted by inspection, I feel convinced that there is an opening for my design of link outside of going through the mill.

Yours respectfully,

E. H. CANT,

Engineer Onomea Sugar Co., Papaikou, Hawaii.

*FEED WATER FOR BOILER PURPOSES.**

BY. W. H. EDGAR.

I will try to devote one hour to feed water for boiler purposes and then the next hour to lubricating oils. Of course it is understood that I am not here in the interests of any one line of theory; there is nothing in the statements and figures I might give this evening that can refer to any one class of preparations or methods of handling feed waters in the boilers, or referring to any one class of oils. There is no reason why I should mention any form of cylinder or engine oil that is not made by more than ten or twenty different concerns.

The different theories of handling scaling salts in a steam boiler and the deleterious actions that take place from soluble salts are well known to the different chemists throughout the country. Of course they differ to some extent in their opinions. In taking up boiler feed water treatment, we first have the existing condition of the steam boiler, and we have the water which contains the mineral salts, according to the soil through which the water percolates. Water is a great solvent —possibly the easiest solvent we have in chemistry—and it takes up carbonate of lime, as bi-carbonate, sulphate of lime, which is gypsum, and carbonate of magnesia, a saline, which are the scale-forming salts. Of course oxide of iron and aluminum enter into the scale formation. The water takes up sulphate of soda, chloride of soda, carbonate of soda, and sometimes a little potash, but potash and soda bases are practically alike in their chemical and physical action. The lime and magnesia salts form a scale—a hard crustation, which is a perfect non-conductor. Different tests have proven that iron will conduct 37 heat units, while lime and magnesia scale the same thickness will transmit one.

The statement was made a short time ago by a certain professor in one of our Eastern Universities that it did not require any more fuel to evaporate a given quantity of water per 24 hours and develop the same horse power in a boiler. I do not believe we could heat the water very rapidly through a saucer or porcelain dish which would be the equivalent of such a scale formation; and then again, if we look at it from another standpoint, the iron plate and the tubes are transmitting the heat units to the water as delivered from the fire; consequently, in the thickness of this plate we have stored a certain amount of heat. If the temperature is brought up to

*Paper read at a meeting of the Honolulu Engineering Association, Oct. 26, 1903.

quite a high degree of heat, we have practically an investment of heat units constantly in the transmitter. Now, in addition to the boiler plate, if we should place a non-conductor between the boiler plate and the water, we certainly increase our investment of heat units, and also concentrate our heat in a given part, as the non-conductor lies between our transmitter and the water, and we are raising our iron to a higher temperature; consequently, we must get rid of the scale formation by physical force or chemistry. If the scale is allowed to get too thick, and we use some substance that would remove it too rapidly, it would settle on the crown sheet, the fire sheet, or in the lower tubes of the water tube boilers where the heat is greatest, and we would concentrate the heat in these lower tubes, or the fire sheet, to such a degree as to bring the iron to a red or white heat, or the melting point, when it would start to flow and the pressure would then force it out. It is very dangerous to remove that scale formation too rapidly; it is also very dangerous to have too much of the scale formation in this heater, and especially where you have an oil fire it is much harder to distribute your heat units than with coal fire. In considering the conditions down here, and the water I have been expecting a little trouble in changing from coal to oil.

In handling the scale formation, I find that mixtures of tannin extracts, with a little bark or wood starch, such as slippery elm, beech wood, willow wood, or the heart wood of the oak tree, gives us a favorable starch, which, when introduced into a steam boiler, yields a small percentage of acetic acid. If we were to use a little acetic acid in our feed water it would attack the iron, but using the wood pulp and introducing it into a steam boiler, which is practically a still of high efficiency, we break it up, and by this method of distillation get a little acetic acid, which, in the presence of the scale formation, is chemically arrested by the lime and other salts before it is allowed to pass over. The tannins, under the degree of heat existing in the steam boiler, act on the carbonate of lime and the carbonate of magnesia, giving us a tannate of lime and tannate of magnesia, which is a light, floculent powder that does not settle on the bottom nor float on the top; it has not the affinity for hot metal that carbonates of lime and magnesia have, and in the presence of an excess of tannin extracts they will not adhere as scale formation, but remain as an inert powder which can be readily washed out by the opening of the boiler. We have found in experimental work across the country (I am now referring to several railroad laboratories which are at present carrying on a great deal of experimental work in this line) that the use of about 6 to 8 per cent. of tannate of soda, with an excess of tannin, will answer as a traveling base in a steam boiler. In the laboratory, in the open vessels, I have found it difficult to produce tannate of calcium from tannate of soda; but in the steam boiler, under a high degree of heat and pressure, a little traveling soda base will readily produce calcium tannate; the reason I say traveling base, is owing to the fact that I am referring to the mixture carrying five times its weight of tannin extract (the extract known as 52 Twaddle, and containing about 33 per cent. of tannin). We find that it is impossible to break up sulphate of lime with tannin, and if we used soda-ash, which would change sulphate of lime, giving us normal carbonate of lime in suspension and sulphate of soda in solution, every pound of sulphate of lime which we took out of the water would give us, approximately, one pound sulphate of soda in solution, and in the course of a week's run in a large steam plant we would reach the point of saturation where the water would not hold any more in solution, and consequently would cake at the bottom of the vessel, and the soda sludge is a far greater non-conductor than a lime scale. This sludge is a heavy mass, and will produce a bag in the fire sheet and buckle the tubes instantly. We further find that in most plants of today they are getting more or less oil back into the boilers, and where a carbonate of soda might saponify an animal oil, it would have no action whatever on a mineral oil other than to form a sticky, tenacious, adhesive mass, which would be a mechanical mixture. I believe you have had some trouble on the islands from oil in your boilers, due to oil combining mechanically with the chloride of soda, or common salt, which form this sticky, tenacious mass, becomes quite buoyant, and is carried with the circulation through the submerged part of the boiler, adhering to the hotter parts of the boiler, and consequently gathering on the lower tubes, or fire sheet, causing blisters. Animal oil going into the boiler combines with the lime chemically, forming oleate of lime, or insoluble soap. The little particles come together, floating on the top of the water, sticking one to the other until they gather into a mass, which becomes heavier and more buoyant and is carried the same as the chemical mixture, its physical action being the same. If you had carbonate of soda to excess in the boiler, it would act on this animal oil mixture, saponifying the water, which would cause foaming. The object of using some bark or wood starch is to produce a little acetic acid, which will arrest the carbonate radical and prevent saponification. Foaming is brought about by the presence of a little saponified matter in the water. If you use a little vinegar (acetic acid), you could stop the foaming immediately; sometimes it is preferable to use a little vinegar, even at the cost of the iron.

It has been found in experimental work that sulphate of lime can readily be broken up by adding a little sugar to the mixture. The sugar acts as a reducing agent and reduces the sulphate to a sulphide, freeing the lime base, which is immediately taken up as a tannate in the presence of the tannin extract. A little cane sugar, possibly a little grape sugar, but more especially cane sugar, also gives us saccharated calcium oxide and calcium saccharate, which, in turn, under the conditions existing in the steam boiler, are readily broken up, reducing down into calcium oxalate, and as calcium oxalate it readily converts into calcium carbonate. We further find that a very small percentage of sugar produces these results, and it has further been found that molasses cannot be used, or any sugar syrup or juice, on account of the acids present. Sugar will not attack metal the same as acids present in sugar juice or molasses. We also find that we have to avoid the use of hemlock extract and a great many other extracts which contain tannin, due to the volatile oil and resin present, which, in a steam boiler, acts as oxidizing agents to the iron, and are the cause of some of the general corrosive actions in our steam pipes, heating systems, etc. All these deleterious actions today have to be watched. Steam plants are very expensive; it is a very easy matter to remove incrustation, but it is also a very easy matter to ruin the plant. A steam plant properly handled, on a fair water, ought to last for many years. I believe it is possible to keep all the sediment out; also to prevent all corrosive action. Years ago, when crawling into boilers and examining the pitting and grooving, I invariably found the pitting in round-shaped holes in the plate, and in a certain two or three or half-dozen tubes generally located in the same part of the boiler and covered with a yellow scab. I tapped this scab with a hammer, and underneath was a fresh, dark-red powder. I gathered this powder very carefully, and in analysis found it to be Fe-2 (O H-6) (Ferric hydrate), which readily converts into its oxides and finally into the black, magnetic oxide of iron, and may be found in the mud drum or lower part of the boiler in the mud. I have gathered it by washing the muddy water in a bucket with a hose. This pitting is galvanic action (electrolysis), and it is due to the fact that a steam boiler is practically a galvanic battery. The metal is subjected to different degrees of heat, and is constantly delivering heat units and transmitting same to the water; consequently, we have a constant molecular activity going on between the molecules in the boiler plate and tubes. Copper and brass are negative, and iron positive, at all times. The reason we do not get pitting in all cases is due to the fact that we have no electrolyte present connecting the poles of the battery; this is due to the fact that the water is saturated with lime—the water is alive. Take the lime out of the water, or have an excess of soda over that of lime so that you have an alkaline solution, and you immediately produce an electrolyte between the poles and also a battery solution. We have further found that iron will act negative to iron positive, and in all galvanic battery work the positive pole is always destroyed. You can stop this electrolysis by simply putting your battery out of service by adding a little lime over that of the soda, or, which is better, adding a mixture of tannin and slippery elm bark, beech wood or wood pulp, which will satisfy the water and take up the lime and soda. Any unsatisfied condition, chemical or solvent property, existing in the water, will satisfy itself on these organic substances and not attack the metal. This theory of electrolysis has been carefully watched for years in large heating plants, where the returns from the heating system have been so large that the water was almost pure. This theory has been proven for years in marine service where they use sea water. The large vessels have to hang tons of zinc in the boilers, or they could not get along; that is to say, the boilers would be eaten out so rapidly that they are compelled to hang zinc in them to save the iron. The zinc is simply a substitute for the iron; it is a more positive metal, and the positive pole locates on the zinc. Tannin also causes a coagulation or congealing action on oil in a steam boiler, and, followed by a constant boiling and high heat, produces an inert powder. The chemical composition of the oil, both the hydrocarbon (mineral oil) and the carbohydrate (animal oil) being destroyed, as well as changing the physical properties, this powder is inert, and washes out the same as the tannate mixtures of lime. Those who are acquainted with practical chemistry know that there are great results to be produced with the high degree of heat in the steam boiler where we get the distillation and general breaking up of chemical compositions, and can get reactions with organic substance more rapidly, more far-reaching than some of the strongest acids in the mineral kingdom. We are also acquainted with the fact that there are a great many reactions in chemistry found existing in nature that cannot be produced in the laboratory. We further find that a great many of our experiments in the laboratory which are perfect have proven to be a failure on a large scale in factory work. Chemistry is a constant study; we cannot do any more than to keep at it and experiment; we accept chemistry as we find it.

I have tried not to overlook any conditions that may exist in a steam boiler, or ideas I may be able to give in the way of theory confirmed by practice. If there are any conditions or ideas which you would like to submit, I shall try to answer them.

Mr. Gartley—

"The statement was offered that absolutely pure water in a boiler is a very serious matter, and causes very rapid deterioration.

"It is also popularly believed by many engineers that soda is the only proper compound.

"Another statement very generally made and accepted is, the under many conditions the introduction of a small quantity of oil in the water is a great help—that is, mineral oils.

"How do potatoes act in a boiler, and what about the machine for boiling them?"

Mr. Edgar—

"The pitting and grooving produced by an absolutely pure water is due to the solvent properties of the water. Water is the most general solvent we have, and it is apparent that, according to Nature, it must hold something in solution; it takes up one salt or another in the absence of lime and magnesia, and it will take up other salts or attack the iron in the absence of mineral salts.

"In the boiling of water in a steam boiler you are producing bubbles, which are solid sheets of water; they break and spatter in the steam space, and the steam, being delivered from the boiler with great velocity, carries these little particles of water with it. If each water sheet contained a little soda, you would then have a slight alkaline reaction, which is sufficient, under the conditions in a steam boiler, to produce galvanic action.

"In treating on destruction of the iron, if you should have a great deal of trouble in your feed pipes, and the submerged parts of your boiler and the surface of the iron should waste away, it would be well to look for sulphuric acid. If you should have considerable oxidation going on between your pumps or heater and boiler, it would be well to look for chloride of soda. In practice we have found that, when we reach the degree of heat of about 212 deg. F., there is considerable chloride of soda broken up and the chloride liberated, and we get both an indirect soda action and a direct chlorine action on the iron at this point, and we further get a little chlorine in the steam space of the boilers. Such action would take place all along the steam header, and would be similar to the grooving mentioned in too pure a water.

"The third question Mr. Gartley asked was the use of petroleum in the steam boilers: In the oil fields of Pennsylvania, in the early days, they added a little straight mineral oil to the steam boiler to prevent scaling; they put the oil in first, and then filled the boiler with water, and as the oil raised with the water it formed a film over the submerged parts of the boiler, and lay between the water and the iron, preventing the lime and magnesia present from getting a purchase and forming an incrustation. In the hard, scale-forming waters of the East, the oil was not very successful; it did not injure the boilers, because a mineral oil has not that sticky, tenacious nature, and is not capable of combining chemically with lime; consequently, it did not form an insoluble soap. The oil used formed a film, preventing any substance from further adhering. A little animal oil adhering to the iron would carbonize quickly; the charring would destroy a certain amount of the iron. The mineral oil being a direct hydro-carbon, would last longer and would not have quite such an action on the iron.

"The potato, to my way of thinking, is a start on the right theory of handling water in the steam boiler. The peel of the potato contains a large percentage of tannin, and the pulp gives a certain percentage of dextrous sugar, and ultimately a saccharate. They had to give up the use of potato, due to the great quantity of pulp or sludge they formed in the steam space of the boiler. They did not get a result of more than 2 or 3 per cent. of the potato pulp; the balance was a sludge, and spattered into the steam space and burned on the iron, where it was gradually charred. If they could take the potato peeling and add old tea leaves, they could make compound enough to handle part of a hotel plant. Have you noticed at home how your kettle scales? Sometimes it gets about 1-32 of an inch thick. Take the tea leaves, coffee grounds or potato peelings and boil in the kettle for a few hours; the scale will then come off as a red sludge. The red-brown condition is due to the presence of tannin. There are a great many ways of producing tannin cheaper than by using potato peelings. You can get an extract in such a form that a one-quart measure would equal a bushel and three-quarters of potatoes. I have had occasion to get the tannin percentage of nearly all roots and barks, wood, peelings, etc., etc., of the vegetable kingdom.

"If there are any further questions or points on this subject, now or later on, I shall be glad to answer them."

CONTRACT LABOR IN HAWAIIAN ISLANDS.

BY KATHARINE COMAN.

(Continued from November No., page 516.)

In September, 1889, a committee of the planters petitioned the ministry to convene an extra session of the legislature to consider an amendment to the Constitution making provision whereby "Chinese might be admitted to the Islands as plantation laborers and whereby Chinese so admitted and Chinese now in the country and employed as common laborers might be restricted to agriculture." The petition was refused on the ground that such an amendment had already been voted down. The ministerial policy was then stated as follows: "First, the excessive proportion of Chinese in the Kingdom and their rapid encroachment upon the various businesses and employments of the country, require adequate measures to prevent the speedy extinction in these Islands of Western civilization by that of the East, and the substitution of a Chinese for the Hawaiian and other foreign population. Second, the perpetuation of Anglo-Saxon civilization, introduced into these Islands and adopted by the Hawaiian people early in the present century, is essential to the continuance of a free government and of the political independence of this Kingdom, and such civilization can be perpetrated only by retaining a population who have been educated therein and who comprehend the workings and benefits of popular representative government. Third, we believe that self-preservation, by nations as well as by individuals, is a principle universally recognized." Reviewing the policy of other nations, the ministry undertook to justify by analogy the restrictions imposed by the Hawaiian government on the immigration of Chinese. The United States had excluded such immigrants; Canada and the Australian Colonies had imposed restrictions; the islands of the Pacific, the Philippines, Samoa and Tahiti, had taken measures to protect themselves against Chinese competition, in Java and the Straits Settlements, hostile legislation was imminent. A statistical study of the situation in Hawaii followed, and it was demonstrated that Chinese competition meant the speedy substitution of the oriental for the native or European workmen. The Chinese in the Kingdom then amounted to one-fifth of the entire population, having increased from 5,916 in 1878, to 19,737 in 1888; but the number employed as plantation laborers had not increased in the interval. There was abundant evidence to show that the majority of the Chinamen who elected to remain in the islands at the expiration of their contracts had gone into various trades. The cabinet declared its conviction that the presence of Chinamen was a menace not only to the industrial but to the social well-being of the islands. Their immorality, their secretiveness, their apparent disregard of human life, their imperviousness to western ideas were dwelt upon with much earnestness. After this extensive preamble it is somewhat disconcerting to find the cabinet arriving at a conclusion practically identical with that of the planters: "1. That no Chinese other than teachers and officials shall be allowed to come into this country except in the capacity of laborers. 2. That no Chinese be admitted as laborers unless the agricultural necessities of the country require it. 3. That

Chinese not now engaged in trade or the mechanical occupations, be prohibited from hereafter engaging therein."

The representations of the planters prevailed with the next legislature so far as to secure the admission of Chinese as agricultural laborers for a term not exceeding five years. If found in any other occupation such immigrant was to be arrested and returned to China. The planter engaging such laborers must make a deposit of $75 for each laborer, deducted from his monthly wages. This was reserved by the Board of Immigration to meet the expense of this return passage. In 1895 a further modification of the Exclusion Act was allowed. Permits to import Chinese coolies might be granted to an employer who bound himself to introduce European or American agricultural laborers equal in number to one-tenth of the Chinese permitted him. This was to be accomplished within one year after the date of the permit. Such European or American laborers were to be accompanied by women in the ratio of twenty-five women to one hundred men. The government was to defray the passage of women and children to the amount of $130 per family; the planter was to defray the passage of the men and any surplus for women and children. A good and sufficient bond was required for the performance of this obligation. In the next two years 7364 Chinese were brought in under this arrangement. Another immediate consequence of this legislation was a renewed effort to obtain European laborers. Two hundred and twenty-seven Germans were imported in 1897, and 255 Italians in the year following, together with as many Galicians from Austro-Hungary. These efforts were rather perfunctory: the laborers so introduced were but poor material and meant nothing as a solution of the labor problem.

The significant achievement of these years of agitation was the negotiation of the convention with Japan by which an important labor supply was opened. In 1879 the Board had appropriated $10,000 for the introduction of laborers from Japan, and the Hawaiian consul at Tokio was instructed to submit the following terms to the Japanese government: Laborers coming to Hawaii were to enter into contract to work on a sugar plantation for a term of from three to five years. Wages were guaranteed at the rate of ten dollars per month for men and six dollars per month for women. Forty per cent. of the immigrants were to be women, and the Board was to pay half the expense of the passage of the women and whole expense for all the children brought in. The people were to be returned at government charge if at the end of the contract years, they did not wish to remain in Hawaii. These terms were sufficiently generous, but the Japanese authorities demurred. They were willing that the people should emigrate to Hawaii, but expressed themselves as decidedly adverse to any scheme of contract labor that seemed likely to place Japanese subjects in a position "similar to that of the Chinese in Peru, Cuba, or even California." There followed a remarkable "higgling of the market," the Board of Immigration eagerly meeting demand after demand of the coy Japanese officials. It was finally agreed that free passage to and from Japan should be provided for the laborers, their wives and children, that they should be guaranteed employment without signing an advance labor contract, and that the minimum rate of wages, fixed before sailing, should be nine dollars per month with food, or fifteen dollars without food. The Board promised to provide laborers in the latter case with standard rice at five cents a pound.

At last (February, 1885) the first shipment of Japanese coolies was received,—616 men, 159 women, and 108 children. Instructions as to treatment were embodied in a circular letter to the planters: "The understanding with the Japanese government is that while the immigrants remain under their original contracts they are to be under the immediate guardianship of the government, and that the planters to whom their contracts are assigned are the agents of the government, the latter being really responsible on the original contracts at all points. It has further been distinctly considered and determined by the government that no employer or overseer (luna) shall be permitted under any circumstances (except in self-defense) to strike or lay hand upon any contract laborer who is a government ward. This determination is made binding by agreements to this effect, actually entered into; and it is rendered all the more important when considered in the light of the sensitive nature of the Japanese race, in particular, which renders any rough handling of the laborer abortive, if intended to secure obedience. It must therefore be understood by all employers that blows or other violence used against a contract laborer, except in absolute self-defense, will be deemed sufficient ground for the withdrawal of the assignment made to them of any person so dealt with." A special commission of inspection of Japanese laborers was created with a Japanese as chief and with interpreters for each island where Japanese were employed, charged with the investigation and amicable settlement of disputes that might arise between laborer and employer.

The function of these interpreters was at first resented by the planters, but they proved so helpful in obviating difficulties that the plan was in the end heartily approved. The ambition of the government to settle the labor problem once and for all by inducing "the voluntary immigration of a friendly people," seemed about to be realized. Of 3457 Japanese brought into Hawaii in the next three years (1885-1888), 2431 elected to remain under a second contract, 632 remained as free laborers, 291 returned to Japan, and the remainder died in the islands. The arrangement was regarded with such satisfaction by the Japanese government that propositions for a convention fixing the conditions of this immigration were favorably received. The year 1886 saw the ratification of a convention between the Empire of Japan and the Kingdom of the Hawaiian Islands.

Sixty-two thousand Japanese were brought into the Hawaiian Islands under this convention, twenty-five per cent. of them being women. As may be inferred from the insistent demand of the planters for Chinese laborers, the Japanese were not entirely satisfactory. From the outset they were difficult to deal with, proving to be restless and self-assertive to a degree hitherto unknown in the cane-fields of Hawaii. They were, moreover, remarkably clannish, clubbing together for the championship of their common interests in a way that was distinctly embarrassing. They showed no disposition to marry with the Hawaiians and, while readily adopting American dress and ways, cherished allegiance to their native land with peculiar tenacity. They found their way into the skilled trades even more rapidly than the Chinese. The danger that Hawaii might be orientalized was greater than in the days of unstinted Chinese immigration. In fact the fear that the Islands would be annexed by Japan was one of the prime factors in the demand for annexation to the United States.

The industrial transformation wrought by annexation was far more profound than the political. The immediate legislative consequences were the exclusion of Chinese laborers and the prohibition of the penal enforcement of labor contracts. The absolute exclusion of the Chinese had been anticipated as had also the prohibition of the further importation of contract laborers. But it had been supposed that existing contracts would hold to the expiration of the stipulated terms. Indeed the planters had imported an unusually large number of Japanese (19,908 in 1899) in anticipation of prohibition laws. The immediate effect of the marshal's proclamation was an epidemic of strikes. Of the twenty-two strikes recorded by the United States labor commissioner for 1900, twenty were undertaken by plantation laborers, all of them Japanese. The causes given throw a good deal of light on the aspirations of the inscrutable Jap: "for discharge of overseer, for increase of wages, increase of water supply at dwellings, payment of damages for injuries received by an employee, and against retention of part of wages withheld in accordance with original contracts," "for cancellation of contracts," "against being compelled to work regular hours," "for increase of wages from $17.50 to $26 per month," "for reinstatement of discharged employees," "for employment of Japanese instead of white overseer," "against the task system," "against being compelled to work on holidays." This sudden advent of full-blown trades unionism took the planters by surprise. For the moment the laborers had the upper hand. But under the auspices of the Planters' Association a uniform scale of wages was soon agreed upon by which all the managers were to abide. The monthly wage for field labor was fixed at $18, $19, and $20, according to the distance from the nearest town. This advance represents a considerable increase in cost of production. But the conditions of immigration are altered. Passage money is now advanced by immigration companies, chartered by the Japanese government, which exact a bond for repayment from the immigrant or from his relatives. In case a man absconds the sum deposited is confiscated to the treasury of the company. The government reserves full right to limit the number of laborers who may be recruited and the towns or districts from which they may be drawn.

Much misunderstanding has risen concerning this method of meeting the labor demand of the sugar planters. The evil reputation of the coolie trade—a reputation well-earned in Cuba and in the Chincha Islands—has attached itself to every attempt to transfer the superabundant population of Asia to the lands where their labor is in demand. It must be acknowledged that the penal enforcement of a labor contract is inconsistent with the trend of modern labor legislation. It suggests slavery. But how otherwise could the laborer, guiltless of property and in debt for his passage money, secure his master against breach of contract? The labor contract, moreover, was the only practical method of securing labor in a country so remote from the sources of supply. Laborers could be induced to immigrate only by the offer of passage prepaid and a guarantee of employment at a living wage. Planters could not be expected to meet these terms unless they were guaranteed against loss by a legal claim on the laborer for a definite term. Finally social security would have been threatened by the importation of alien laborers in numbers far exceeding the native population, but for the fact that these men were held upon the plantations by the labor obligation.

At a citizens' meeting called in 1869 to discuss the labor question the president of the Board of Immigration thus defended the government against the charge of being "man-stealers" and "slavers": "You cannot bring laborers here without first making a contract to pay certain wages and to provide food and lodging,—these are the inducements for them to come, and the government must hold out these inducements or they would not come,—whether Chinese or others. Under our laws all are alike. There is nothing like slavery here, and immigration cannot be made freer than it is.'' In his report of 1886, Charles Gulick, president of the Board, summing up a comprehensive review of the immigration policy of the Hawaiian government, asserts: ''The coolie system known as such has never existed here. The only law between employer and employee is the Master and Servant Law, than which none is milder or more equitable, requiring as it does the specific fulfillment of contracts. The law protects the laborer in all his rights, and affords no more protection to employers in theirs.''

Contract labor as practiced in the Hawaiian Islands was fully justified by the peculiar social and industrial conditions there prevailing. As administered by the Board of Immigration, the system was calculated to advance the interests of the laborers quite as much as those of the planters. That it has done so is evident from the property statistics of the twelfth census. The value of the farm lands in which Chinese are interested as owners, part owner, managers, cash-tenants, or share tenants is $2,700,335. The Japanese have had less time in which to acquire property, but their interest is estimated at $438,020. The Chinese residents in the Hawaiian Islands pay taxes on $2,205,339 of personal property, the Japanese on $177,307. It would not be difficult to prove that for the oriental laborer the labor contract has been the highroad to fortune.

The importation of thousands of orientals under a semiservile labor contract had, however, a discouraging effect on free immigration. In so far the Hawaiian labor system is quite comparable to the slave labor system of our southern states. This tendency has been recognized and deplored by all public spirited citizens of the islands. In a memorial addressed to the Hawaiian Commission in 1898 this attitude is stated as follows: ''The evils of the penal contract system and its tendency to depreciate the standard of labor as an honorable calling have been recognized and appreciated by the great bulk of the intelligent people of Hawaii, and it is almost entirely fallen into disuse, except with relation to the newly imported immigrants and the securing of the advances made to and on account of them. So great has been this tendency that the census of 1896 shows that of approximately 35,000 laborers only approximately 10,000 were working under contract and these almost exclusively under contracts made abroad.''

Much might be said in favor of the labor contract as a wholesome regulator of immigration. The normal demand for labor so expressed is a safer stimulant than the specious promises made by steamship and railroad agents. Under a wise and efficient administration such as characterized the Hawaiian Islands and still obtains in British Guiana and the Strait Settlements, the misfits resulting from voluntary and unrestricted immigration have been largely avoided. The insuperable objections to the labor contract, appreciated to the full by the defendants of the system, is the difficulty of enforcement. How can the courts compel a man who has no property but his bodily energies to fulfill his contract and so meet the money obligations incurred in transportation? Obviously he has nothing to forfeit but this freedom. But is not penal enforcement inconsistent with personal liberty? This dilemma has been fully treated in two important meetings of the Hawaiian supreme court. In the case of John H. Wood vs. Afo—(alias Cheong San Quong), 1873, the court affirmed:

> "This statute (the Master and Servants Act) was enacted, of course, in reference to the business of the country. The production of the country must be gathered and secured, or manufactured when secured, and if neglected they deteriorate and are essentially damaged, and the law in question is designed to prevent persons from wilfully violating their contracts and doing damage to their employers. It is, in degree, as essential to the sugar planter that his employees should remain with him to perform the service as agreed upon during the crop, as it is for the seamen to remain on the ship during the voyage. A sugar plantation encounters as many adverse winds as a vessel, and is quite as likely to be endangered in crop time as vessel is on a lee shore, when all hands are required. In many countries where labor is plenty and heavy advances are not necessary to procure laborers, this law is not necessary. But the legislature, in their wisdom, passed the law as applicable to the condition of affairs here.
>
> But it is contended that it is in restraint of one's liberty,—why more so than any other contract which a man makes and honestly fulfills? If a mechanic undertakes to build a house, it occupies his time and diverts his attention from other pursuits, which, perhaps, he might prefer. Every man in public office is under obligation to attend to its duties, and it is often in restraint of his wishes, but no one thinks that it impairs his liberty. The court is of the opinion that it is immoral to fail to fulfill a contract without a reason. The man when he makes the contract understands perfectly well its terms, and receives advantages in advance, and, is fully complied with, how is his liberty interferred with? It was optional whether he made the contract or not, but when he has made it and received part payment, it is not true liberty regulated by law for him to abandon his obligations and defraud his employer out of the money advanced. But it is said, bring your action for damages. This may be regarded in most cases as mere mockery. It is to incure a bill of costs without the slightest probability of receiving the amount awarded. There would be some strength in the argument if the damages could probably be secured, but the legislature, in their wisdom, considered the necessities of the business done here as well as the condition, moral and physical, of the people who usually enter into contracts of this character."

Again in 1891, the court was called upon to decide upon the apparent inconsistency between penal enforcement and personal liberty. Mioshi, a Japanese under contract to the Board of Immigration and assigned to the Hilo Sugar Company, sued for exemption on the ground that the contract was a violation of the Constitution, since he was unwilling to serve, and Article XI of the Constitution of 1864 and 1887 prohibit "involuntary servitude." The judges ruled that the contract was constitutional. "Article XI was enacted while the Master and Servants Act was in full force, hence it could not have contemplated contracts to labor voluntarily undertaken. A fair and honest contract to work for another, willingly and freely made with a knowledge of the circumstances, cannot be said to have created a condition of involuntary servitude. The contract which creates the state or condition of service, if it is voluntary when made and the conditions and circumstances remain unchanged, except that the mind of the one who serves is now unwilling to fulfill it, is it not by that fact changed into a contract of involuntary servitude forbidden by law. If the contract is lawful and constitutional in its inception, it does not become illegal or unconstitutional at the option of the parties."

Quite in accordance with this ruling, is the Act of the Legislature of 1892 re-enforcing the penalties for desertion from service. If the servant refused to serve he was to be imprisoned until he consented. If he returned but again deserted, he could be fined not exceeding five dollars for the first offence and not exceeding ten dollars for the second offence, and in default in payment of the fine be imprisoned at hard labor until payment. For every subseqent offence he might be imprisoned at hard labor not exceeding three months and he must then serve the remainder of his original term.

By annexation to the United States, Hawaiian institutions were brought under direct control of a people accustomed to express their notions of individual liberty in legislation. Doubtless ignorance and prejudice were mingled in the popular discussion of the terms on which the islands should become an integral part of our government; but the denunciation of contract labor had its origin in the conviction that the penal enforcement of a personal obligation is inconsistent with democracy, that it belongs not to the future but to the past, that it must go the way of those other forms of forced labor slavery and serfdom. The history of labor systems in America goes far to justify this point of view. Indentured servants ceased to be brought into the Atlantic colonies before the close of the eighteenth century. African slaves became the labor reliance of the Southern States while the North secured an adequate supply of free labor by immigration. Slavery was abolished in 1863. The coolie trade was prohibited under heavy penalties in 1864. The importation of contract laborers was rendered illegal by the law of 1885, and all engagements made in advance of landing in this country were declared void.

A similar tendency is evident in European legislation. In England, desertion of service on the part of artisans and servants in husbandry was treated as a crime for centuries, and a long series of statutes from 23 Edward III to 4 George IV prescribed penalties of medieval severity. As late as 1866 the servant refusing to labor till the end of his term might be imprisoned at hard labor in a house of correction or suffer abatement of wages, as the magistrate might direct. But the master's right of penal enforcement was destined to give way before the people's demand for personal liberty. The year that gave the suffrage to the ten-pound householder witnessed an important modification of the Master and Servants Act. In accordance with the recommendations of a select committee of the House of Commons (1867) a fine was substituted for imprisonment as a penalty for non-performance except where injury to the master's person or property could be proved. In 1875 a royal commission made an exhaustive report on the vexed question of the enforcement of labor contracts. For the Master and Servants Act was then substituted the Employers and Workmen Act, by which the laborer was permitted to give security for due performance in lieu of paying a fine. Germany was the last of the continental states to surrender the principle of penal enforcement. The Prussian law of 1869 abolished the right of compulsion. No German laborer may to-day be forced to resume his service, though he may be sentenced to pay a fine for damage wrought. Soldiers are not affected by this emancipating legislation, and the seaman's contract, even in the merchant marine, may still be penally enforced in every European port.

The seamen's union of the United States has waged long and bitter war against this last stronghold of compulsory service. Their contention has been carried to the highest tribunals of the land with discouraging result. As late as 1896 the majority of the justices in the Supreme Court sustained the Shipping Law. (Robertson vs. Baldwin, January 25, 1896). The petitioners had sued out a writ of habeas corpus by way of protest against forcible detention on board ship as contrary to the thirteenth amendment. The court affirmed the constitutionality of the penal enforcement of the contract:

> The prohibition of slavery in the thirteenth amendment is well known to have been adopted with reference to a state of affairs which had existed in certain states of the Union since the foundation of the government, while the addition of the words "involuntary servitude" were said in Slaughter-house cases (1873) to have been intended to cover the system of Mexican peonage and the Chinese coolie trade, the practical operation of which might have been the revival of the institution of slavery under a different and less offensive name. It is clear, however, that the amendment was not intended to introduce any novel doctrine with respect to certain descriptions of service which have always been treated as exceptional, such as military and naval enlistments.

The question whether Sections 4598 and 4599 (the penal sections of the Shipping Act) conflict with the thirteenth amendment forbidding slavery and involuntary servitude, depends upon the construction to be given to the word "servitude." Does the epithet "involuntary" attach to the word "servitude" continuously, and make illegal any service which becomes involuntary at any time during its existence? or does it attach only at the inception of the servitude, and characterize it as unlawful because unlawfully entered into? If the former be the true construction, then no one, not even a soldier, sailor, or apprentice can surrender his liberty, even for a day; and the soldier may desert his regiment upon the eve of battle, or the sailor abandon his ship at any intermediate port or landing, or even in a storm at sea, provided only he can find means of escaping to another vessel. If the latter, then an individual may, for a valuable consideration, for a definite time, and for a recognized purpose, contract for the surrender of his personal liberty and subordinate his going and coming to the will of another during the continuance of the contract.

Justice Harlan dissented: "Slavery exists wherever the law recognizes a right of property in a human being; but slavery cannot exist in any form within the United States. The thirteenth amendment uprooted slavery as it once existed in this country and destroyed all of its badges and incidents. It established freedom for all."

The opinion of Justice Harlan was destined to prevail. On December 21, 1898, Congress passed an amendment to the Shipping Act which provided that in case of desertion from an American vessel in ports of the United States, and its dependencies, or in ports of Canada, Newfoundland, the West Indies, and Mexico, the seaman or apprentice so deserting should forfeit all effects left on board and all wages due him. Deserters from an American vessel in a foreign port may suffer the further penalty of three months' imprisonment. But in the ports of the United States, her neighbors and dependencies, the ship-masters' rights of bodily compulsion is finally abolished.

From the foregoing sketch of the tendencies in recent legislation, one must conclude that penal enforcement, the essential condition of contract labor, is an anachronism in the modern industrial order and destined everywhere to be superseded by a higher labor type. Conditions in Hawaii are peculiar in that the abolition of the penal contract was not demanded by the coolies or by the planters, but was imposed by the United States government as a condition of annexation. Public opinion in the United States demanded that the laborer in Hawaii should be as free as the laborer at home. Americans could not comprehend that in a tropic country worked by oriental labor the wage system might be an anachronism.

The years immediately following the abolition of contract labor were full of difficulty for the Hawaiian sugar-planters.

In 1895, the labor commission, reporting on the problems then besetting the employer of labor, declared the wage relation a failure. "It is generally conceded by planters, in these islands and elsewhere, that the system of wage-paying is the least satisfactory of any of the forms of labor employment, because as the wages are the same, it does not stimulate the ambition of the laborer, and, indeed, tends to reduce the amount of labor furnished by each laborer to the product of the least efficient and most thriftless." This is especially true in the case of Japanese laborers, now seventy per cent. of the total labor supply. As a race these laborers are restless, ambitious, and eager for change. In marked contrast to the patient, industrious Chinaman, the Japanese is quick to take offense, ready with his fists and altogether a difficult and unreliable employee. Under no pecuniary bond to his employer and attached to the plantation by no sense of loyalty or self-interest, he requires constant oversight.

The old-fashioned planter has fallen into despair. The more progressive men have hit upon a device that promises well. This is a form of rental similar to farming on shares, except that the lease is taken up not by an individual farmer but by a company of laborers. The planter furnishes land, seed-cane, water, fertilizer, and tools, and performs such portions of the work as require expensive machinery, such as plowing, furrowing and hauling the cane to mill. He also provides house, garden, and fuel to each laborer's family and advances him ten dollars per month towards living expenses. A field of from fifty to one hundred acres is rented to a "contract company" of a dozen or more men. Under a head-man of their own choosing, the co-laborers weed, irrigate, and fertilize the field and strip and finally cut the cane and load it for transportation. The cane is weighed as it leaves the field or, when practical, reckoning is kept at the mill of the raw sugar produced from the crop in question, and each company is paid for its product at the rate stipulated in the contracts. This piece-price varies with the market price of sugar. Two dollars per ton of cane or seven dollars per ton of sugar is the present rate, approximately one-seventh of the total value of the crop.

The purchase system was in the experimental stage when the labor commission made the report above quoted. At that time the method had been tried on some eight plantations with varying degrees of success. Only four managers gave it unhesitating approval. To-day the purchase system is quite the usual method of dealing with Japanese laborers, since it is a relation that brings out their best qualities. The "contract company" at its best is a labor-guild, associated in the bond of a common interest. The jealous attention given to their cultivation of a crop shows in marked contrast to the perfunctory performance of hired laborers. The company men irrigate with careful attention to the quality of the soil, begging for more fertilizer than has been allotted them, stealing it from the warehouse in case of necessity. They go to the fields in advance of the day-laborers and stay after hours, weeding or stripping or guarding against fire. The result, under the same conditions of soil and water supply is a yield greater by one-fourth or one-fifth than the crop produced by the labor gang supervised by a luna. The planter reaps an enhanced profit, and the earnings of the men are twenty-five per cent. more than they would receive as wage laborers. There is indeed good reason to hope that the purchase system will prove the ultimate solution of the labor problems in the Hawaiian Islands.

THE SUCCESS OF MECHANICAL FILTRATION BY MEANS OF THE STANDARD SAND FILTER.

A full exhaustive and quick crystallization can only take place if the sugar crystals in the boiling or cooling down masse-cuites come continuously into close contact with the mother-liquor. This fundamental principle on which all modern systems of crystallization are based can only be complied with if Mr. Geo. Stade's rule (vide International Sugar Journal, Vol. 5, No. 51) "that good sugar can only be made out of clean filtered concentrated juice" is followed, i. e., if an effective mechanical filtration over Sand takes place.

Experiments just made and published (vide Journal d. f. d. s., Vol. 44, No. 24) gave the following figures:

Quality of Masse-Cuite boiled down	Hours of crystallization required for exhaustion	per 100 Masse-Cuite yield in Sugar
I. Without any filtration..	145	35.36%
II. With partial bad filtration	125	38.77 "
III. With perfect filtration over Sand	99	42.94 "

a. This indicates that the Standard Sand Filter saves:

$\frac{1}{3}$ of the time required for complete crystallization equal to $\frac{1}{3}$ of the mixing-cooler—(crystallizer) capacity required for crystallization purposes.

b. From above result follows further the important fact of an increased yield of over 7½% in sugar from masse-cuites.

GEORGE STADE.

PROVISIONAL METHODS OF THE HAWAIIAN SUGAR CHEMISTS' ASSOCIATION, ADOPTED OCTOBER, 1903.

Provisional Methods of Analysis adopted, and Recommendations approved, by the Hawaiian Sugar Chemists' Association, at the annual meeting, October 26 and 27, 1903.

To the Members of the Hawaiian Sugar Chemists' Association:

The methods of analysis adopted as provisional at the annual meeting, October 26 and 27, 1903, as well as general recommendations approved, were placed in the hands of the Executive Committee for compilation and editing; and as a result of this work the Executive Committee submits the following, feeling sure that the methods, while in no way perfect, are a distinct advance over those proposed before.

BASIS OF CALCULATION.

The amount of sucrose coming to the mill in the cane is to be used as the basis of calculation; and this amount is found from the weight of the cane and the per cent. sucrose in the cane calculated by the following formula:

$$\%\ \text{Sucrose in Cane} = \frac{\%\ \text{Sucrose Normal Juice}\ (100-\text{F.})}{100}$$

where F is the fibre in the cane.

NORMAL JUICE.

Normal juice is the actual cane juice, and its composition is to be found as follows:

Density. The density of the normal juice is found by averaging the density of the juices from the different sets of rollers when no water is used for maceration. Such a test should be made once a week, and the factor

$$\frac{\text{Density mixed juice} \times 100}{\text{Density 1st Juice}}$$

used for daily calculation.

Purity. The purity of the normal juice is found by averaging the purity of the mixed juice with that of the residual juice in the bagasse. The purity of the residual juice should be determined in one sample of bagasse each day, as directed under bagasse. The purity of the normal juice is expressed:

$$\frac{\text{Extr.} \times \text{Purity Mixed Juice} + (100-\text{Extr.})\ \text{Purity Residual Juice}}{100}$$

Sucrose. The sucrose in the normal juice is expressed:

$$\frac{\text{Brix. Nor. J} \times \text{Purity Nor. J.}}{100}$$

An example of these calculations may be taken as follows: Extraction assumed, 94.5. Purity of mixed juice, 86. Purity of residual juice, 59. Density of 1st juice, 18. Density of mixed juice, without maceration, found to be 99.8% of density of 1st juice.

From these figures we find Density of Normal Juice=

$$\frac{18 \times 99.2}{100} = 17.86$$

Purity of Normal Juice is found to be

$$\frac{94.5 \times 86 + 5.5 \times 59}{100} = 84.5;$$ and from these the sucrose

in the Normal Juice is found to be

$$\frac{84.5 \times 17.86}{100} = 15.09$$

It will be noted that an assumed extraction enters into these calculations; but it will be found by making the calculations, using different assumed extractions, that the difference in the final result is insignificant, no matter what the extraction is assumed within the limits of ordinary work.

CANE.

Fibre only is to be determined in the cane, and samples should be taken at least twice a week.

Samples should be taken by cutting equal lengths from the top, middle and bottom, cutting midway between the joints, and this portion divided into four equal parts by quartering, one part being taken for analysis. The sample should be so taken that the portion reserved for analysis is about 500 grams.

The whole sample of cane is first weighed, then finely cut and treated with cold water for two hours, changing the water every half hour; or, if preferred, placing the sample in a linen bag and treating with running water for the same length of time. It is then to be digested with water at 60° to 70° C. for one hour, changing the water every fifteen minutes; then with boiling water for one hour, changing every fifteen minutes, and dried to constant weight at 100° C.

In determining the fibre in the cane, the amount of field trash weighed with the cane should be determined once a day on one average car; the amount of fibre determined, and this added, pro rata, to the amount of fibre found in the sample of clean cane.

JUICE.

Juice samples should be taken continuously by some automatic sampling device, and run into a container containing a sufficient quantity of either mercuric chloride or formalin. The density should be taken with a Brix spindle graduated at 27½° C., and correction made for temperature. Before taking the density the juice should be freed from air, particles of trash removed from the top and sand or dirt allowed to settle.

For the determination of sucrose, the juice may be either weighed or measured, using 100 c. c. or double the normal weight as measured in a sucrose pipette. No more acetate of lead should be used than is sufficient to effect clarification. Juice samples should be analyzed at least every six hours.

BAGASSE.

Bagasse should be sampled at the carrier, the whole amount from one slat being taken, well mixed, and placed in a close container. Samples should be taken at least every six hours and analyzed separately.

Sucrose in Bagasse. Fifty grams are taken, placed in a tared litre flask, 450 c. c. water added, the solution made slightly alkaline with 5 c. c. of a 5% solution of sodium carbonate, the flash connected with a vertical condenser and boiled slowly for one hour. After cooling, the flask and contents are weighed, the diffused liquor strained, 99 c. c. placed in a 100 c. c. flask, clarified with a few drops of acetate of lead, filtered and polarized. The polariscope reading, divided by 3.8, gives per cent. sucrose in diffused liquor. Grams of diffused liquor times per cent. of sucrose in diffused liquor= Grams sucrose in diffused liquor; and

$$\frac{\text{Grams sucrose in diffused liquor} \times 100}{\text{Grams bagasse used}} = \%\ \text{Sucrose in bagasse}$$

For example:

Bagasse used, 50 grams. Bagasse contains 52% fibre.

Flask + Bagasse + Water........	626	gms
Flask	126	gms
	——	
Bagasse + Diffused Liquor........	500	"
Fibre in bagasse	26	"
	——	
Diqused liquor	474	"

and for 100 gms. bagasse we have diffused liquor 948 gms.

If polariscope reading is 1.°, we have % sucrose in diffused liquor = 0.263 and

$$\frac{948 \times 0.263}{100} = 2.49 \text{ \% sucrose in bagasse.}$$

Density of Residual Juice. The density of the residual juice in the bagasse is found by carrying out the diffusion outlined above, without the addition of sodium carbonate, determining the density of the diffused liquor with a pyknometer, and finding the Brix corresponding to the specific gravity. For instance, if in the example given above the S. G. is found to be 1.0028, this corresponds to Brix .564, and the Brix of the residual juice will be

$$\frac{.564 \times 948}{100} = 5.34$$

Purity of residual juice is then expressed:

$$\frac{\text{\% Sucrose in diffused liquor} \times 100}{\text{Brix diffused liquor}}$$

For moisture in bagasse a portion should be dried to constant weight at 100 ° C.

EXTRACTION.

By extraction is menat the percentage of sucrose in the cane which is obtained in the mixed juice. When the term extraction is used in any other sense, it should be so defined.

Having the % sucrose in the cane from the formula:

$$\text{\% Sucrose in cane} = \frac{\text{\% Sucrose in Normal Juice } (100-F)}{100}$$

and the % sucrose in the mixed juice by analysis, the calculation of extraction is simple, being expressed:

$$\frac{\% \text{ Sucrose in mixed juice} \times \text{Wt. of mixed juice} \times 100}{\% \text{ Sucrose in cane} \times \text{Wt. of cane}}$$

Where it is not possible to weigh the cane, this weight may be calculated from the sucrose in the mixed juice and the % sucrose extracted per 100 cane.

Below is an example full enough to need no explanation:

Normal juice Density Brix	18.58
Mixed Juice Density Brix	16.76
Sucrose	15.71
Purity	93.70
Residual Juice Purity	78.
Extraction assumed	93.
Cane % fibre	11.5
Bagasse—Sucrose	4.14
Moisture	46.36

Purity of cane juice (normal juice)

$$\frac{(93.7 \times 93 + (78 \times 7)}{100} = \ldots\ldots 92.6$$

Sucrose % normal juice

$$\frac{18.58 \times 92.6}{100} = \ldots\ldots 17.21$$

Sucrose % cane

$$\frac{17.21 \times (100-11.5)}{100} = \ldots\ldots 15.23$$

Soluble solids % bagasse

$$\frac{4.14 \times 100}{78} = \ldots\ldots 5.31$$

Insoluble solids % bagasse

$$100-(46.36 + 5.31) = \ldots\ldots 48.33$$

Bagasse % cane

$$\frac{11.5 \times 100}{48.33} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 23.79$$

Sucrose in bagasse % cane

$$\frac{23.79 \times 4.14}{100} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .985$$

Extraction % cane

$$15.232 - .985 = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 14.245$$

Extraction % sucrose in cane

$$\frac{(15.23 - .985) \times 100}{15.23} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 93.53$$

Juice lbs 5364500

Sucrose in juice lbs.

$$\frac{5364500 \times 15.71}{100} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 842762$$

Sucrose in cane lbs.

$$\frac{842762 \times 100}{93.53} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 901060$$

Cane lbs.

$$\frac{901060 \times 100}{15.23} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5916349$$

WASTE MOLASSES.

Total Solids. The total solids in molasses are to be determined in the following manner: About two grams of filter paper are crumpled or coiled, tied with thin wire, and dried. This is weighed in a tared test tube 5 in. x 1 in. The paper is then removed and about two grams of molasses are weighed in the tube and mixed with 2 c. c. of hot water. The paper is replaced evenly in the tube and absorbs the whole of the liquid. The tube is then stoppered with a doubly perforated stopper, placed in a water bath, and the water kept boiling for 2½ hours, a slow current of air, dried over calcium chloride or sulphuric acid, being drawn through the tube. The tube is weighed after cooling and the loss stated as water, the difference between the weight of molasses taken and the weight of water stated as total solids.

Aliquot samples should be taken daily and the total solids determined in the accumulated samples once a week.

For daily reports the solids may be determined by dilution and spindling, diluting the molasses with its own weight of water, using a Brix spindle graduated at 27½° C., correcting for temperature, and doubling the reading for the solids in the original molasses.

Sucrose in Molasses. Sucrose is to be determined by the Clerget method, using either neutral acetate of lead or subacetate with acetic acid for clarification.

PRESS CAKE.

Sucrose in Press Cake. Take 25 grams of sample, beat to a thin paste with hot water, transfer to a 100 c. c. flask, cool, add acetate of lead, then acetic acid to set free any combined sucrose, make to volume, filter and polarize, stating the reading as % sucrose.

Moisture in Press Cake. Thirty grams are dried to constant weight at 100° C.

Where it is not possible to weigh the press cake, one average cake should be weighed each day and this taken as the basis of calculation.

POLARIZATION, GENERAL.

Clarification. Neutral acetate of lead or subacetate with acetic acid, should be used as the clarifying reagents in preparing solutions of all sugar house products for polarization.

Readings. All solutions should be polarized immediately after thy are prepared. A number of polariscope readings should be taken for each tube and the mean taken as the true polarization.

Quartz Plates. Quartz plates used for control should be compared with some standard plate at a central station. The Director of the Planters' Experiment Station has such standard plates.

ENTRAINMENT.

A continuous sample of the evaporated water should be taken and analyzed every six hours. Two litres are evaporated to 100 c. c. and the sucrose determined either by polarization, or by inversion and determination of the invert sugar by Fehling's Solution.

DILUTION.

Dilution is to be stated as dilution of the normal juice, as follows:

$$\frac{\text{Brix mixed Juice} \times 100}{\text{Brix Normal Juice}} - 100$$

The following resolutions, covering some of the ground not included in the methods outlined above, were passed unanimously by the Association:

"Resolved, That it is the sense of this Association that in view of the misleading results of glucose determinations in sugar house work, and the great amount of time necessary for this work, time which might more profitably be employed in doing more necessary work, that glucose determinations be not included in the scheme of sugar house control."

Similar resolutions were passed, covering ash, acidity and alkalinity determinations, with the provision that special investigations be conducted by a committee, with respect to their value.

In the matter of exchange of reports between plantations, it was the opinion of the Association that weekly and not daily reports should be used in such exchange.

It is of the utmost importance, if chemical control of sugar house work is to have even an approach to accuracy, if actual losses are to be determined, and so-called undetermined losses eliminated, that the juice coming to the boiling house should be actually weighed; and members of the Association are urged to use all means in their power to effect the necessary equipment to accomplish this. (Signed)

P. A. G. MESSCHAERT,
HORACE JOHNSON,
E. C. SHOREY,
W. McQUAID,
F. E. GREENFIELD,
C. C. KRUMBHAAR,
T. F. SANBORN,
C. F. ECKART,
Executive Committee.

Honolulu, 31st Dec., 1903.

To the Editor Hawaiian Planters' Monthly,

Dear Sir:

The George M. Newhall Engineering Co., Ltd., Philadelphia, has lately sent some illustrated circulars to a number of people in Honolulu interested in our sugar industry. These circulars show evaporators, vacuum pans, centrifugals, etc., of that company's make, and include a photograph of the sugar factory of the Francisco Sugar Co. at Guayabal, Cuba. It may interest our friends in Hawaii to know that this modern factory was originally designed by the Honolulu Iron Works Co. for the McBryde Sugar Co. under a contract for the furnishing of this entire factory erected on their estate on Kauai. When in the spring of 1900, the American Sugar Co. determined to discontinue the development of their estate on Molokai, the new factory they had ordered from Mr. O. B. Stillman had just arrived, and as it was offered for sale on advantageous terms, the McBryde Sugar Co. decided to purchase it and to cancel the above contract.

The writer, who was then in New York, was therefore intructed to dispose of the steel buildings, by that time party completed in the works of Messrs. Miliken Bros., New York. This he succeeded in doing in September of that year to Mr. M. Rionda, Vice-President of the Francisco Sugar Co., Cuba, and furnished at the same time the general arrangement drawings and specifications for the complete machinery installations in the factory, which was finally erected at Guayabal by the George M. Newhall Engineering Co., Ltd. It has been a great satisfaction to the Honolulu Iron Works Co. to hear on various occasions of the successful working of this plant, which is almost a duplicate of the Olaa factory designed and built by them.

Yours very truly,

C. HEDEMANN,

Manager, Honolulu Iron Works Co.

ABSTRACT OF REPORT RECEIVED FROM THE AMERICAN BEET SUGAR CO., OF ECONOMY AND CAPACITY TESTS OF THE "STANDARD" AND "LILLIE" QUADRUPLE EVAPORATORS AT OXNARD SUGAR FACTORY.

TESTS EVAPORATING APPARATUS.

	Standard Clean.	Lillie after four weeks continuous running.
Density juice entering per hour	13.9 Brix.	19.9 Brix.
Density juice discharged per hour	63.9	63.1
Temperature juice entering Fahr.	178°	180°
Temperature juice discharged Fahr.	140°	198°
Temperature steam entering Fahr.	233°	240°
Quantity juice entering pounds per hour	136,835	110,065
Quantity juice discharged pounds per hour	28,385	31,423
(a) Pounds water evaporated	108,450	78,642*
Pounds water condensed 1st effect=steam used.	28,640	19,290
Temperature water discharged 1st effect	205°	204°
(b) B. T. U.'s abstracted from steam	28,034,920	18,257,985
From items (a) and (b) we deduce:		
B. T. U.'s used per pound of water evaporated	258.5	232.16
Ratios of heat (steam) consumed assuming 100 for the "Lillie"	111.3	100.00

Notes: (1) The bodies of the "Standard" were lagged with non-conducting material, those of the "Lillie" were not. (2)

*Guaranteed evaporation of the "Lillie" is equivalent to the evaporation of 70,045 pounds of water per hour.

No account was taken of the heat lost in removing the air and incondensible gases from the effects. This loss is much greater in the "Standard" than in the "Lillie." (3) The "Standard" was worked with the juice running forward while the "Lillie" was worked reverse, as indicated by the high temperature (198°) of the discharged juice. With the juice entering at as high a temperature as 180° the "Lillie" works more economically forward than reverse.

If allowance were made for these three conditions the ratio of heat used in the "Standard" would be considerably higher, very likely 116 or 118 instead of 111.3.

The "Standard" was designed by the Engineers of the American Beet Sugar Co. and is a first-class apparatus of its kind.
